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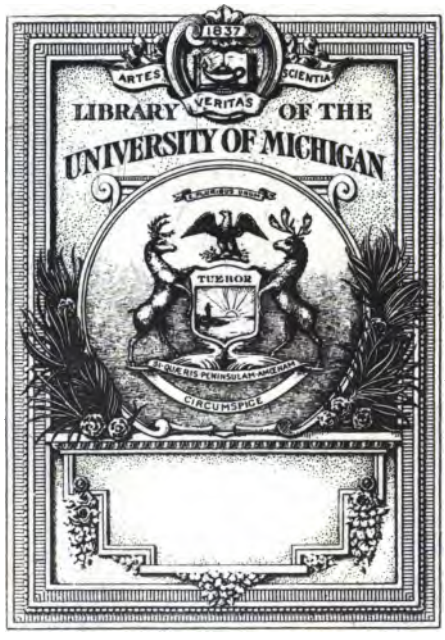

THE GIFT OF
Arkansas Bureau of Mines

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MINERALS IN ARKANSAS

INCLUDING
A REVIEW OF OIL AND GAS
CONDITIONS

BY
JIM G. FERGUSON
COMMISSIONER OF
MINES, MANUFACTURES AND AGRICULTURE
STATE OF ARKANSAS

LITTLE ROCK, ARK.
1922

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Dr. Wm. F. Manglesdorf,
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John C. Small,
Editor of Publications

Dr. N. F. Drake,
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Directory of State Officials Associated With the Mining Industry

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UNITED STATES BUREAU OF SOILS

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Washington, D. C.

DOCTOR JOHN CASPER BRANNER,

Foremost Authority on Arkansas Geology, in Appreciation of Whose Service to the State this Page is Gratefully Dedicated.

INTRODUCTION

Importance of Arkansas As a Mineral State

ARKANSAS has elbowed Pennsylvania, the parent of petroleum, out of fourth place in oil production; she produces twice as much bauxite as all the Western Hemisphere; she was first to discover Fuller's earth; she has the largest and best deposits of whetstone; she has a superior grade of smokeless coal; she has the purest deposit of chalk in North America; she has the only known deposit of soapstone west of the Mississippi river; she has in Magnet Cove the most wonderful aggregation of rare and curious minerals known to the geologist, and at Hot Springs, the hottest thermal waters in the world.

These facts, backed up by government authorities, are grouped here to get the attention of those who are unfamiliar with the state's mineral resources and to prepare their minds for a lot of other big things that can be said about Arkansas' underground wealth, developed and undeveloped. The world is beginning to take notice of Arkansas, the mysterious stranger in the mineral world.

More than thirty useful minerals can be mined or quarried in abundance in Arkansas, and there are a hundred other minerals for which the future may find some economic use. At the great world fairs where all the states bring for display specimens of their mineral products, Arkansas demands more exhibit space than any other state in the Union and surprises the stranger not only with the great variety of its minerals, but with their superior quality.

The value of the mineral products now aggregates close to $100,000,000 annually, one-half as much as the value of all of our factory products and one-fourth as much as is derived from all our agricultural activities.

Arkansas stands high as an agricultural state. In many lines of manufactures it holds a leading position. It is now coming to be regarded as one of the important mineral states. It is unique among the states in that it has three substantial sources of income—three bank accounts, as it were.

Oil Leads All the List.

Oil now ranks first in commercial importance on the long list of Arkansas minerals. The discovery well was brought in at El Dorado on January 10 of last year and within ten months the production had reached 72,000 barrels daily with new wells being completed every week. The value of Arkansas crude oil, produced in 1921, was $23,344,960. There are 598 producing wells and more than 100 other wells being drilled.

Gravity tests of the El Dorado crude oil is 34.30, Baume, and the gasoline content is 30.7 per cent. In production Arkansas now ranks fourth among the states and in the quality of its oil and gas the El Dorado field is among the most valuable in America, it is claimed.

More than $6,000,000 has been invested in drilling operations and many millions more in oil and gas leases in the Eldorado field. All of the large

companies are represented and development is progressing with wonderful rapidity, every new well adding thousands of dollars to the productive capacity of the state.

Two Natural Gas Fields.

There are two natural gas fields in Arkansas, the Fort Smith field, which has been producing gas for twenty years, and the El Dorado field, developed about one year ago. The Fort Smith field includes portions of Sebastian, Crawford and Scott counties, and extends into Oklahoma. The present capacity of this field is approximately 250,000,000 cubic feet of gas daily, twenty per cent of which may be used under the state maximum production law. It is estimated that Fort Smith and its neighboring industries use 10,000,000 cubic feet a day, leaving a surplus of 40,000,000 cubic feet daily. This gas is found at depths of from 750 to 3,175 feet. The product is dry, clean and odorless and under government tests shows a heating record of 1.057 British thermal units.

In the El Dorado field there are at this writing 32 gas wells, each producing from one million to 25,000,000 cubic feet of gas per day. The first gas well was brought in by the Constantin Company in 1920, and was shortly followed by the bringing in of the nearby Busey oil well. The wells are all within a short distance of El Dorado, to which city the gas is piped for domestic and industrial use. The difference between the Fort Smith and the El Dorado gas is that the Fort Smith gas is dry and does not produce gasoline, while the El Dorado gas is wet and has a considerable gasoline content.

Before the discovery of oil and gas, the leading mineral of the state was coal and it still is a source of considerable wealth, the production being 2,000,000 tons a year. The coal-bearing area of the state is 1,584 square miles in extent, reaching from Russellville on the east, through Pope Johnson, Logan, Yell, Franklin, Crawford, Sebastian and Scott counties to and beyond the Oklahoma border.

About Clarksville and Russellville in the eastern part of the field, the product is a high grade semi-anthracite, and in the western part of the field there is produced a high grade semi-bituminous coal of almost smokeless quality. It is estimated by mining engineers that there is in sight some 850,000,000 tons of this coal, which at the present rate of mining will last for 350 years. The heating value of the coal, which lies between 13,700 and 14,700 British thermal units, and its specific gravity (average 1.35), place it among the best coals in the United States.

First in Bauxite Mining.

Practically all of the bauxite used for the manufacture of aluminum ware, chemicals and abrasives in the United States and probably 70 per cent of the world's supply of this important material, is produced from Arkansas mines. The bauxite area lies partly in Pulaski and partly in Saline county, between Little Rock and Benton. The large reduction plant of the American Bauxite Company is at Bauxite, Arkansas. The average production is around 500,000 tons per annum. The ore is mined from open pits, dried and shipped to Pittsburgh, Pennsylvania; Elizabeth, New Jersey; Niagara Falls, New York; Detroit, Michigan; St. Louis, Missouri; and other cities, where it is consumed in the large aluminum and chemical industries. Bauxite in value ranks third among the major minerals of the state.

Other Minerals Worth While.

Zinc, lead, manganese, iron and copper are metalic minerals found in Arkansas and at times mined with considerable profit. There has been a large production of zinc and lead in the northwestern counties of the state and during the world war the mining of manganese proved to be profitable. The deposits of iron and copper, while promising, have not been developed to any considerable extent as yet.

The mining of diamonds has been restricted to a small area in the vicinity of Murfreesboro, Pike county, and the principal operations are carried on by the Arkansas Diamond Corporation, which company has erected a $300,000 reduction plant in the field. Hundreds of pure gems have been recovered from igneous formation which bears all the marks of an extinct volcano. One of these stones weighed 18 carats in the rough and in quality compared with the finest of South African diamonds. Pike county has the only diamond mine in America.

Fuller's Earth and Antimony.

There is a deposit of Fuller's earth between Benton and Hot Springs which has been worked at several different times and which promises to add another important mineral to the long list accredited to Arkansas. This material is used for the clarifying of oil and for medicinal purposes.

Antimony is an anti-friction metal used as an alloy in the manufacture of babbit and type metal. It is found in Sevier and Howard counties. Asphalt of a good quality exists in Pike and Howard counties. The most extensive and the highest grade of chalk known to exist in the United States is at White Cliffs, Little River county, where a project has been undertaken to establish a big cement plant.

Clay for the manufacture of brick is present in seventy of the seventy-five counties of the state. In Hot Spring and Sebastian counties there are deposits of high grade fire clay. Pottery clay is found in Saline, Pike and other counties, this including kaolin from which the famous Niloak artware is made. There is probably no state so rich in clays, both as to quantity and variety.

Glass sand of excellent quality is present in large quantities at Guion, Izard county, and near Bryant, in Saline county. Graphite of good quality is found in four counties of the state. Gypsum, one of the materials useful in the manufacture of cement, is present in three counties of Southwest Arkansas. Iron pyrites, running 50 per cent sulphur, is found near Hot Springs. This is one of the materials from which sulphuric acid is made.

Lots of Building Stone.

Building stone is plentiful in Arkansas and constitutes one of the most important items on the list of minerals. Near Little Rock there is a vast mountain of the most beautiful gray and pink granite and from the quarries near Batesville there is produced the splendid marble such as was used in the construction of the outer walls of the new state capitol. Marbles, limestones and sandstones are found also in other parts of the state.

Novaculite, an oily rock from which whetstones are made, is found in Southwest Arkansas, giving this state first place in the production of this class of abrasives. Ochre and other mineral paints are found in different parts of the state. The only soapstone or talc deposit known to exist west of the Mississippi river is in Saline county. There is a valuable deposit of

tripoli or infusorial earth at Butterfield, and the same material is reported as being present in five other counties of the state.

Lignite or cannel coal, which has been tested for oil and gas production with very favorable results, is present in an area extending northwestward from Camden. The vein ranges from two to six feet in thickness. It is said to yield as high as 38 gallons of oil per ton and 11,386 cubic feet of 22.3 candle power gas. The distillates are used in the manufacture of paint and various proprietary medicines, being produced by a plant at Chidester.

Phosphate Rock and Slate.

In the northern part of the state, extending from Batesville probably to the western line of the state, is a deposit of phosphate rock which next to the deposits of Florida and Tennessee are probably the most valuable in the United States. There are deposits elsewhere in the state, but none so promising as those of North Arkansas. From phosphate rock is made phosphoric acid, one of the most valuable materials for the fertilization of soil. A new process of treating the rock has been devised which promises to revolutionize the industry of acid phosphate manufacture and open new markets to Arkansas' abundant stores of phosphate.

Slate of excellent quality and in a variety of colors is found in a belt extending westward from near Little Rock to the border of the state, being formerly quarried at Slatington. In the manufacture of composition roofing there is a demand for crushed slate of certain shades which should create a new and larger market for Arkansas slates, which have not heretofore been able to compete in the slate trade with the superior Eastern states. Several roofing manufacturers are investigating the possibilities of devloping the slate deposits in Polk and Montgomery counties.

Need of a Permanent Geological Survey

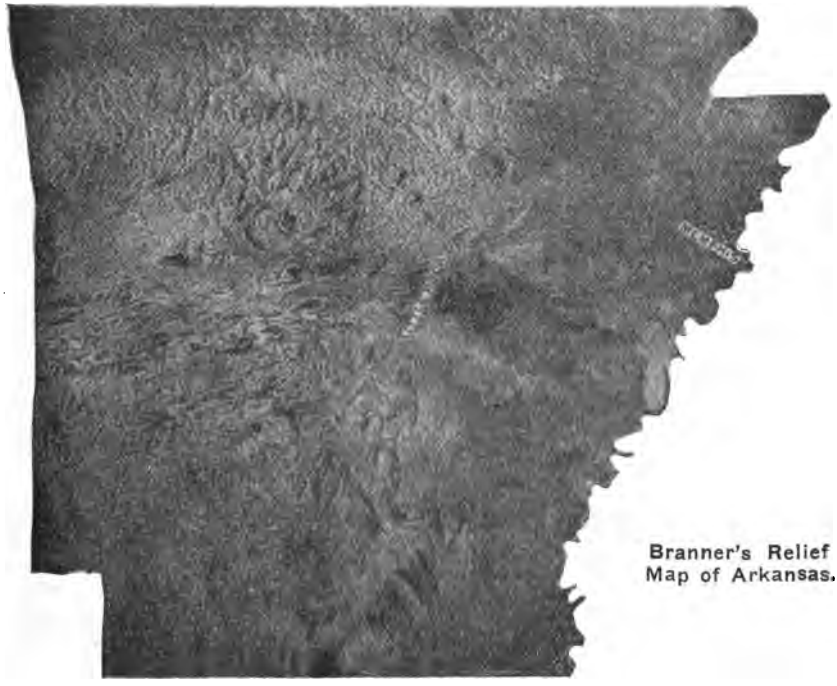
This recitation of the mineral resources of the State but emphasizes the need of a permanent and active Geological Survey in Arkansas, such as will give substantial aid to the forces which are seeking to develop the underground wealth of the State and at the same time safeguard and husband the public's interests in these valuable assets. I am hopeful that the next Legislature will find it agreeable to make liberal provisions for the re-establishment of the Survey, which for the lack of funds has been unable to conduct any field work for several years.

Dr. John C. Branner, in a letter to me suggests ten big things that ought to be done on the geology of the State. These are:

1. Bring up to date the work on the coal lands and publish the report.
2. Report on the petroleum and natural gas resources.
3. Report on the fertilizers.
4. Report on the soils of the state, their origin, distribution and treatment.
5. Report on the clays, kaolins and fuller's earths.
6. Revise and publish the report on the Lower Coal Measures.
7. Report on the structural materials including Portland cement.
8. Report on the state water supply including underground waters.
9. A comprehensive work on the general geology and geologic history of the state.
10. The preparation and publication of a large scale topographic and geologic map of the state.

Commissioner of Mines, Manufactures and Agriculture.

Little Rock, Ark.
January 3, 1922.



Branner's Relief Map of Arkansas.

GEOLOGY AND GENERAL TYPOGRAPHIC FEATURES OF ARKANSAS.

BY HUGH D. MISER, With Permission of the U. S. Geological Survey.

TOPOGRAPHY.

The topographic features of Arkansas reveal considerable diversity and may be grouped into several natural divisions which are briefly described below.

The line passing from a point near the northeast corner of the State in a general southwesterly direction through Little Rock to Arkadelphia, Clark County, and thence nearly due west through De Queen, Sevier County, divides the State into nearly equal parts or halves. The southeast half of the State is a comparatively low plain which is a part of a broad belt of country known as the Gulf Coastal Plain. This plain in Arkansas ranges in elevation from 100 to 700 feet above sea level, and is divisible into a series of rolling uplands lying 200 to 700 feet above sea level and a series of nearly level to gently rolling valleys and lowlands lying 100 to 300 feet above sea level. Both the uplands and lowlands have a gentle southward slope. Crowleys Ridge is the most prominent physiographic feature in the northeastern part of the State. It is one-half to 12 miles wide and extends from Helena, Phillips County, northward into Missouri, though it is cut in two by gaps at some places. The crest of the ridge is 400 feet above sea level near Helena, but it gradually rises northward and is 500 feet above sea level in Clay County.

Topography of Boston Mountains Near Jasper. Photo by J. C. Branner.

Most of the northwest half of the State is comparatively elevated, and is divided by the Arkansas River Valley into the Ozark region (including the Boston Mountains) on the north and the Ouachita Mountain region on the south.

The part of the Ozark region lying north of the Boston Mountains is known as the Ozark Plateau and occupies a belt, about 40 miles wide, along the northern border of the State. This belt is made up of two plateaus. The lowest one of these—the Salem Plateau—is in Ordovician rocks and presents an exceedingly rough topography. It forms a triangle whose apex is near Newport, Jackson County, and whose base lies on the Missouri-Arkansas line from Boone County to the east end of Randolph County, but the basin-like area in which Berryville, Carroll County, is situated is also a part of this plateau.

The next higher plateau, known as the Springfield Plateau, is formed by resistant cherty rocks of Mississippian age, and lies between the above-indicated triangle and the north-facing escarpment of the Boston Mountains. It is separated from the lower plateau by a sinuous escarpment which attains a height of 400 feet near Eureka Springs, Carroll County. Much of this pleateau is a gently rolling country but large parts of it are cut by numerous canyon-like valleys. Most of its surface stands between 1,000 and 1,500 feet above sea level.

The Boston Mountains overlook the Springfield Plateau from an irregular north-facing escarpment 500 to 700 feet in height and many outlying peaks of these mountains stand out on the Springfield Plateau. Most of the southern slope of the mountains is less precipitous and passes off gradually into the Arkansas Valley, though at many places it is marked by abrupt descents and is broken by steep-sided canyon-like valleys. This mountainous region has an average width north and south of about 35 miles, and extends east and west a distance of approximately 200 miles, from the valley of Neosho (Grand) River in Oklahoma eastward to the Coastal Plain near Batesville, Ark. The mountain tops form a greatly dissected tableland, which rises 2,200 feet above sea level and 1,700 feet or more above the flood plain of Arkansas River, though a few remnants along the north side stand 2,300 to 2,400 feet above sea level. The mountains are rather rugged and have steep slopes and sharp projecting spurs separated by narrow ravines, 500 to 1,400 feet deep. The slopes are broken at many places by vertical or nearly vertical cliffs, which are due to the alternation of hard and soft beds of rock. Some of the cliffs are more than 100 feet high.

The Arkansas Valley is 30 to 40 miles wide and extends from the vicinity of Little Rock westward into Oklahoma. It is a nearly level plain, most of which is between 300 and 600 feet above sea level; but rising above it there are a great many ridges and several mountains with a nearly east-west trend. Among the mountains are Sugarloaf, Poteau, Petit Jean, Magazine, Whiteoak, and Big Rock mountains and Maumelle Pinnacle. Of these Magazine Mountain, standing 2,823 feet above sea level and 2,300 feet above the surrounding country, is the highest and is also the highest mountain in Arkansas. The statement is made on page 551 of the Encyclopedia Britannica (Eleventh edition, 1910) that this mountain is the "highest point between the Alleghenies and the Rockies." A still higher point ,as shown on the Winding Stair topographic map of the United States Geological Survey, is the west end of Rich Mountain near Page, Leflore County, Oklahoma; it is between 2,850 and 2,900 feet above sea level.

The Ouachita Mountain region is 50 to 60 miles wide and extends from the vicinity of Little Rock westward into Oklahoma. It is composed of numerous, nearly east-west ridges, several intermontane basins, and a dissected piedmont plateau, 15 miles wide, along its southern border. The ridges are narrow and parallel and have steep slopes and sharp straight even crests. Just west of Little Rock they are low, scarcely exceeding 750 feet above sea level or more than 250 feet above the valleys, but they gradually increase in height to the west and on the western border of the State near Mena, Polk County, some of the highest ridges attain an elevation of 2,750 to 2,800 feet above sea level or about 1,750 feet above the valleys. The

—Photo Courtesy U. S. Geological Survey

Solution Valley in Boone Limestone. Residual Masses of White Chert From the Formation Strew the Surface.

intermontane basins are wide valley areas whose upland surfaces range from about 500 to 1250 feet above sea level, being lowest at the east end of the region and highest near the west border of the state, and they are channeled by both deep and shallow valleys. Mena, in Polk County, Mount Ida, in Montgomery County and the southern part of the city of Hot Springs are located in such basins. The piedmont plateau is known as the Athens plateau, receiving its name from Athens, Howard County. It occupies a belt of country about 15 miles wide, lying between the Ouachita mountains on the north and the Coastal Plain on the south, and extending from near Arkadelphia, Clark County, westward into Oklahoma. When the plateau is viewed from the crests of the mountains to the north it appears to be a practically level plain ending abruptly against the mountains, but when it is crossed very little level country is found; the rest is greatly dissected by narrow crooked valleys of southward-flowing trunk streams and by numerous east-west valleys of small tributary streams. The upland surface of this plateau ranges from 400 to 1,100 feet above sea level, being lowest at its east end and along its south side, and highest on the north side in Pike, Howard, and Polk counties.

Geology

GENERAL FEATURES.

The several natural divisions of the State differ considerably not only in their surface features but in the character and age of their rocks.

The exposed rocks of the Ozark region consists chiefly of dolomites, limestones, cherts, sandstones, and shales, ranging in age from Ordovician to Pennsylvanian. The rock beds, though lying nearly flat, have a slight southward dip which is disguised in parts of the region by minor folding and by a considerable, though not large, number of faults. The youngest formations of the region occupy the summits of the Boston Mountains and dip southward from these mountains to the Arkansas Valley.

The rocks in the Ouachita Mountain region are all of sedimentary origin with the exception of two small areas of igneous rocks and their associated dikes. One of these areas is at Magnet Cove, Hot Spring County, and the other at Potash Sulphur Springs, Garland County. The igneous rocks are nephelite syenites and related types and were intruded into the sedimentary strata late in the Lower Cretaceous epoch or early in the Upper Cretaceous epoch. Some of the igneous dikes at and near Klondike, Saline County, have been decomposed to a soft earth to a depth of about 200 feet below the surface, and this earth is being mined and marketed as fuller's earth. The sedimentary rocks consist chiefly of cherts, shales, sandstones, and novaculites; they are 24,000 feet or more thick; and they range in age from Cambrian to Pennsylvanian. At or near the close of the Pennsylvanian epoch they were subjected to intense lateral compression movements which have produced numerous parallel, closely compressed, nearly east-west folds and a considerable number of faults. As a result of these movements the strata at most places dip at angles of 40° or more from the horizontal. The structure of the region, taken as a whole, is that of a vast compound anticline, which is known to geologists as an anticlinorium. The principal anticline extends from near Little Rock to the vicinity of Mena. In general the oldest strata are exposed near the middle of this anticline and the youngest northward and southward therefrom, but, on account of the deformation of the strata by folding and faulting much alternation of older and younger beds is found everywhere in going in a northward or southward direction across the region.

The Arkansas Valley lies between the southward monoclinal slope of the Boston Mountains to the north and the uplift or anticlinorium of the Ouachita region to the south and is thus a synclinal trough. The rocks of the valley consist of 24,000 feet or more of sandstones and shales which contain workable beds of coal over much of its western part. They are of Pennsylvanian age, though some of the oldest rocks exposed on the south side of the valley are probably of Mississippian age. The strata like those in the

Ouachita Mountain region, were compressed at or near the close of the Pennsylvanian epoch into east-west folds and have been faulted to some extent, but the folding has been less intense than that in the Ouachita region. The anticlines are generally narrower and steeper than the synclines; there is a tendency for the anticlines to be steeper on their north sides; and the folding becomes more gentle toward the north. The structure bears a close relation to the topography, the long, narrow ridges indicating moderately to highly inclined rocks. Buttelike mountains, such as Poteau, Sugarloaf, and Magazine mountains, indicate practically horizontal rocks in synclinal basins.

The sedimentary strata underlying the surface of the Gulf Coastal Plain are chiefly clays, marls, sands, and gravels, and are of Lower Cretaceous, Upper Cretaceous, Tertiary, and Quaternary ages. They lie in a nearly horizontal position, though they have a general dip of 100 feet or less to the mile to the south and southeast. They were deposited upon a fairly smooth floor of Paleozoic rocks. This floor has been reached in deep wells at Nashville, Howard County, and at other places near the northwestern border of the Coastal Plain, but over most of the southeast half of the State it has been so deeply buried that it has not been reached in wells. The Cretaceous and younger strata overlying it along the east border of the State are more than 2,500 feet thick and those along the south border are more than 3,000 feet thick.

Intrusive igneous rocks occur in the Coastal Plain on and near Fourche Mountain, which, is a few miles south of Little Rock, and in small areas near Bryant and Bauxite in Saline County. They consist of pulaskite ("blue granite") and nephelite syenite ("gray granite") and several other related varieties of rock. Associated with the igneous rocks and with the adjacent Tertiary sediments are important deposits of bauxite, the chief ore of aluminum. Other igneous rocks, known as peridotite, occur in four small areas near Murfreesboro, Pike County. The largest of these, so far as known, contains about 75 acres. Much of the peridotite has been decomposed to earth and soft rock to a depth of 200 feet or more, and in this earth and soft rock diamonds have been found. The igneous rocks in the Coastal Plain, like those in the Ouachita Mountain region, were intruded late in the Lower Cretaceous epoch or early in the Upper Cretaceous epoch.

The sedimentary rocks of Arkansas have been carefully studied over much of the State and have been grouped into numerous formations to which names have been applied. By means of the fossils in them, and by the determination of the relations of the strata one to the other, they are assigned to the different geologic systems and series. Some rock formations in the State contain no fossils, so that their age assignment is dependent entirely upon their relations to overlying and underlying rocks whose ages have been determined by means of fossils. There are many minor and major unconformities that break the succession of the rocks; and on account of the geologic events that produced the unconformities many rock formations thin out and are absent over large and small areas. The rocks in each of the natural divisions of the State are briefly described below in the order of their age, with the oldest first and the youngest last.

Ozark Region

ORDOVICIAN SYSTEM.

Jefferson City dolomite.—The Jefferson City dolomite is exposed in the northeastern part of Marion County and in other counties farther east, and so far as known is the oldest exposed formation in Northern Arkansas. It consists of at least 300 or 400 feet of gray dolomite and chert, in which a few fossils have been found.

Cotter dolomite.—The Cotter dolomite, 500 feet or more thick, is exposed over large areas in many counties in the Northern part of the State, but has been studied in greater detail west of Baxter County than it has east of that

county. The thickest outcrops are in Northern Boone County and other counties farther east. Berryville, Carroll County, and Cotter, Baxter County, from which the formation takes its name, are situated on the dolomite. The formation consists mainly of two kinds of dolomite—a fine-grained earthy, white to buff or gray variety known as "cotton rock," and a more massive medium-grained gray variety whose weathered surfaces are rough and dark. Besides dolomite it contains chert that is sparingly fossiliferous and also contains thin layers of sandstone and shale.

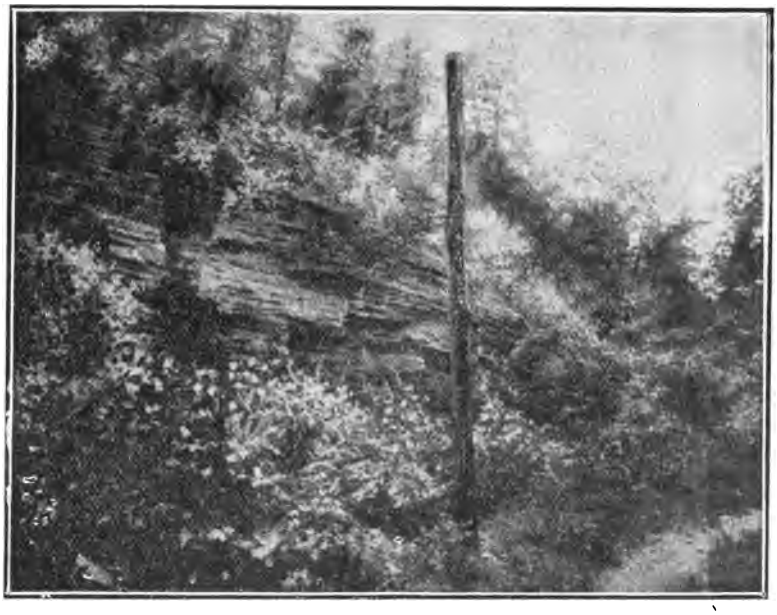
Building stone is quarried from the formation near Beaver, Carroll County. It is compact gray magnesian limestone or dolomite, in beds from 2 to 4 feet thick. The best beds afford durable building stone of pleasing color.

Cotter Dolomite, East of Beaver. Photo by J. C. Branner.

Powell limestone.—The Powell limestone, 0 to 200 feet thick, is widely exposed in Benton, Carroll, Boone, Marion, Newton, and probably other counties farther east, but is absent at some places in the counties here named. It is a fine-grained gray or greenish-gray magnesian limestone, usually free from fossils, but there are a few thin beds of green shale and at some places there is a conglomerate at the base. The name of the forma-

tion was taken from the abandoned station of Powell, a short distance southeast of Pyatt, Marion County.

Everton limestone.—The Everton limestone, 0 to 205 feet thick, is widely exposed in Benton, Carroll, Madison, Boone, Newton, Marion, and Searcy counties, and probably others farther east. It is thickest in Boone, Newton, and Marion counties and thin to the north, west, and east. It takes its name from Everton, Boone County, where it is well exposed. The upper part of the formation is 115 feet or less thick and is composed of massive compact dove-colored limestone and some friable white sandstone, but in Marion County much of the limestone contains enough magnesium for it to be classed as a dolomite. The limestone that is free from magnesium is suitable for making lime. The middle part of the formation is a white friable sandstone in massive beds and is known as the Kings River sandstone member, receiving its name from Kings River in Carroll and Madison counties. The sandstone at places is as much as 40 feet thick and is well suited for the



Thin-Bedded St. Joe Limestone, Member of Boone Limestone. Photo by G. T. Adams.

manufacture of plate and ordinary glass. The lower part of the formation is a sandy compact dark-drab magnesian limestone, known as the Sneeds limestone lentil, and varies in thickness from a feather edge to 50 feet. It is not as widely distributed as the middle and upper parts of the Everton. The known exposures are in Marion and Newton counties. The limestone receives its name from Sneeds Creek, in Newton County, on which it is exposed.

St. Peter sandstone.—The St. Peter sandstone—a formation which is widely distributed in the upper Mississippi Valley—is exposed over large areas in Carroll County and most of the other counties farther east. It and the Kings River sandstone member of the Everton limestone are described in the reports of the Arkansas Geological Survey as "saccharoidal sandstone." It is massive and friable, is white or cream colored, and varies in thickness from a feather edge to 200 feet, being thickest to the south and east. It is being quarried for glass sand at Guion, Izard County. Outcrops of this sandstone occur in many of the picturesque bluffs along Buffalo and White Rivers.

Joachim limestone.—The Joachim limestone, 0 to 150 feet thick, is exposed in Newton County and all of the counties between it and Lawrence County. It thins to the north and west and is therefore thickest in its most eastern and southern outcrops. It is a drab-colored fine-grained, sparingly fossiliferous magnesian limestone, and at many places it is sandy and contains thin beds of sandstone which usually occur near the base.

Jasper limestone.—The Jasper limestone, 0 to 50 feet thick, is present, so far as known, only in Newton County. It takes its name from Jasper, the county seat, near which most of the exposures occur. It is a compact

Sandstone in Powell Limestone. Photo by K. F. Mather.

bluish-gray, slightly fossiliferous limestone suitable for making lime, and it affords a beautiful and durable building stone, as is shown by buildings at Jasper that were constructed with it. A bed of white sandstone, 8 to 20 feet thick, is at the base and at some places there are thinner beds of similar sandstone that are interbedded with the limestone.

Plattin limestone.—The Plattin limestone, 0 to 240 feet thick, is exposed over large areas which comprise parts of Sharp, Independence, Izard, Stone, and Searcy counties, and is thickest in the counties to the east. It is a massive, even-bedded dove-colored or grayish-blue limestone which is comparatively free from fossils and it breaks with a conchoidal fracture. It has been quarried at places for building stone and for making lime, for which it is well suited. Certain layers of the limestone are so fine grained as to suggest

that they are lithographic stone of good quality and considerable prospecting has been done for such stone but the search for commercial quantities of it has not been successful. The most promising locality is on West Lafferty Creek in Izard County.

In practically all of the geologic reports on Arkansas the Plattin limestone has been described as the "Izard limestone," but the "Izard," as it was defined, included not only the Plattin but also the Joachim limestone, which has been described above. The Jasper limestone which overlies the Joachim limestone in Newton County was also included in the "Izard limestone," but it is absent in Izard County, from which the "Izard limestone" was named.

Kimmswick limestone.—The Kimmswick limestone, 0 to 55 feet thick, is exposed in Independence, Izard, and Stone counties and so far as known is absent farther west. It is an even-bedded massive light-gray fine-grained slightly fossiliferous limestone, but at places it is coarse grained and at some places its uppermost beds are compact and grayish blue, thus resembling the bulk of the Plattin limestone. Thin lenses and nodules of chert are present at many places but are not sufficiently numerous to prohibit the use of most of the limestone for making lime for which it is probably suitable.

The Kimmswick limestone constituted the lower part of "Polk Bayou limestone" of many of the geologic reports on Northern Arkansas, whereas the Fernvale limestone, which overlies the Kimmswick, constituted the upper part of the "Polk Bayou limestone." In some of the earliest reports the Kimmswick limestone was included in what was then called the St. Clair limestone.

Fernvale limestone.—The Fernvale limestone, 0 to 125 feet thick, is exposed over large areas in Independence, Izard, and Stone counties; small outcrops occur near St. Joe, Searcy County; and one small outcrop is on Little Buffalo River, a mile northeast of Jasper. The greatest thickness of the limestone given above is in Penters Bluff near Penters Bluff station, in Izard County, but the usual thickness at other places in the Batesville manganese district, in which Penters Bluff occurs, is about 100 feet. This limestone is coarse grained, massive, cross bedded, and fossiliferous, is dark gray and pinkish gray in color, and would make a valuable building stone. Deposits of manganese ore occur in the Fernvale limestone and in its residual clays in the Batesville manganese district, which comprises parts of Sharp, Izard, and Independence counties, and they have been worked much of the time since 1849.

The Fernvale limestone was included in the so-called St. Clair limestone of some of the earlier geologic reports on Northern Arkansas, also in the so-called "St. Clair marble" of some of the reports, and in the upper part of the "Polk Bayou limestone" of the more recent reports. It was first identified by E. O. Ulrich as being the same as the Fernvale limestone of middle Tennessee.

Cason shale.—The Cason shale, 0 to 21 feet thick, is present in comparatively smal lareas. The largest of these are in Independence, Izard, and Stone counties, but small outcrops occur near Duff, Searcy County, and Jasper, Newton County. It consists of greenish-gray calcareous shale and smaller amounts of sandstone and phosphate, and besides these it contains manganese and iron minerals. Phosphate is widely distributed in the shale and has been mined at a few places near the abandoned village of Phosphate in Independence County. The mines have, however, not been worked for several years. At several places in the Batesville district—notably the Cason mine 3 miles north-northeast of Batesville—parts of the shale contain a large enough quantity of manganese oxides for such parts of the shale to be mixed and shipped as a low-grade manganese ore. The residual clays of the shale also contain workable quantities of manganese ore. Fossils in the Cason shale have been found at very few localities.

SILURIAN SYSTEM.

Brassfield limestone.—The Brassfield limestone so far as known is present at only a few places; these occur between Duff and Tomahawk, Searcy County, where it is several feet thick, but fossils that have been derived from it through weathering occur in residual clays at the Montgomery mine, 5 miles east-northeast of Cushman, Independence County. It is a granular, light-gray fossiliferous limestone and contains a small amount of gluconite. This limestone has heretofore been included in the St. Clair limestone, but its lithology, fossils, and stratigraphic relations show that it is of the same age as the Brassfield limestone of Kentucky and Tennessee.

St. Clair limestone.—The typical St. Clair limestone, 0 to 100 feet thick, is exposed at many places in Independence, Izard and Stone counties. It is a coarse-grained pinkish light-gray, highly fossiliferous limestone and much of it would make a valuable building stone. The greatest thickness, 100 feet, is at the Cason mine.

Lafferty limestone.—The Lafferty limestone, 0 to 85 feet thick, is a thin-bedded compact earthy, sparingly fossiliferous limestone, of which the upper part is gray in color and the lower part red. The only known occurrence is an exposure 1¼ miles north of Penters Bluff station in Izard County. The name of the limestone is taken from West Lafferty Creek which is half a mile east of the exposure.

DEVONIAN SYSTEM.

Penters chert.—The Penters chert, 0 to 91 feet thick, is exposed within two small areas in Independence County, one being near Pfeiffer and the other near Penters Bluff station from which the formation takes its name. It is a compact gray and bluish chert, though the upper part is dark colored at places. No fossils have been discovered in the chert but its lithology and stratigraphic relations indicate that it is of the same age as the Camden chert of west-central Tennessee and the lower part of the Arkansas novaculite of west-central Arkansas and southeastern Oklahoma. The Camden chert, as shown by fossils, is equivalent in age to at least a part of the Oriskany group of the Northern Appalachian region.

The Penters chert has heretofore been considered to be a part of the Boone chert, which is described later.

Clifty limestone.—The only exposure of the Clifty limestone in Northern Arkansas is on the East Fork of the Little Clifty Creek in the southeast corner of Benton County. It is a sandy, compact, light bluish-gray fossiliferous limestone and the greatest thickness that has been observed is 2½ feet.

Chattanooga shale.—The Chattanooga shale is exposed in Washington, Benton, Carroll, Madison, Searcy, and Independence counties. It is either absent or not exposed in the other counties in Northern Arkansas. It is a coal black clay shale that splits into thin plates and slabs and gives off the odor of petroleum when struck with a hammer. It is thickest near the western border of the State, where it attains a thickness of 70 feet. The shale is generally underlain by a white to brown sandstone, 0 to 75 feet thick, known as the Sylamore sandstone member, which is also thickest in the western part of the State. At some places the sandstone contains chert pebbles and at some places it is phosphatic.

The Chattanooga shale in the reports of the Arkansas Geological Survey is called "Eureka Shale."

CARBONIFEROUS SYSTEM.

Mississippian Series

Boone formation.—The Boone formation, 250 to 400 feet thick, consists in the main of a series of cherty fossiliferous limestones and cherts that has been known as the Boone chert, a name given to the series on account of its wide distribution in Boone County. Below these over a large area in the northern part of the State lies the St. Joe limestone member of the formation, a well-marked bed of gray or pink crystalline limestone, which is the

Unconformity Within Boone Limestone. Photo by E. O. Ulrich.

basal Carboniferous bed. It is easily recognized by its color, texture, and its marked contrast with the beds that usually underlie it. This limestone ranges in thickness from a feather edge to 100 feet and forms an almost unbroken, though very sinuous outcrop from the vicinity of Mountain View, Stone County, to the State line near Seligman, Mo., and is exposed in all of the counties between that county and the western boundary of the State.

Where the cherts are interbedded with much limestone they form, on decay, a fertile soil, such as is found over large areas in Boone, Benton, Washington, and Madison counties. When comparatively free from limestone beds the soil is generally too meager for agriculture and forms the "flint hills" of central Independence County, of western Carroll and northern Madison counties and the watersheds north of Marshall and southwest of Rush Creek, in Marion County, and the hilltops about Elixir Springs, Boone County, and Doddsville, Marion County.

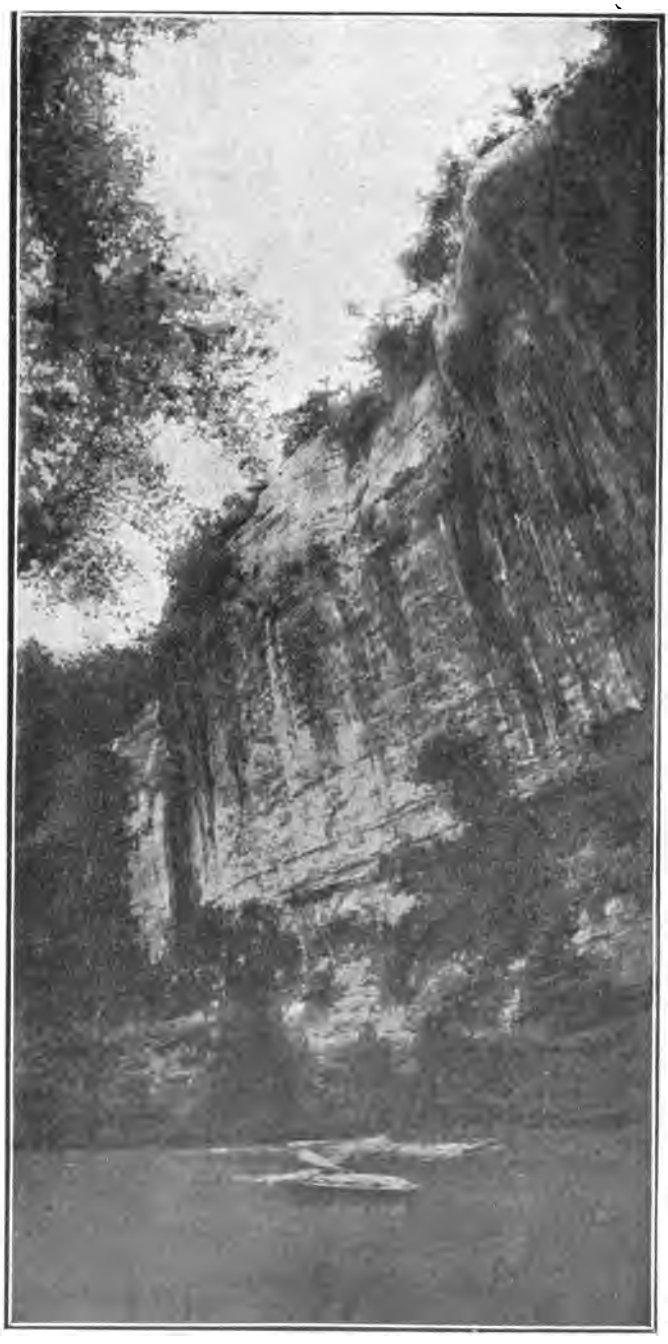
The Boone formation affords an abundance of fractured loose chert on the hillslopes, suitable for road building. The limestone in it is used for building stone and for making lime. A quarry at Pfeiffer, Independence County, is producing a high grade of ornamental limestone.

Moorefield shale.—In the vicinity of Batesville there is a bed of shale lying on the Boone formation. It is well exposed around Moorfield, from which it is named. At and near Batesville it varies in thickness from less than 100 to more than 250 feet. To the west, at Marshall, it is not over 35 feet thick, and evidently it does not extend much farther westward. The shale has a light grayish or bluish color and is very friable. In places it is sandy. A fossiliferous limy phase, several feet thick, at its base has been called "Spring Creek limestone."

Batesville sandstone.—The Batesville sandstone, 0 to 200 feet thick, is so named from the town of Batesville which is built on it. The sandstone is present along the base of the slopes of the isolated hills and mountains north of the Boston Mountains escrapment, in Independence, Stone, Searcy, Newton, Boone, Carroll, Madison, Washington, and Benton counties. It is thickest in its most eastern exposures. The rock is coarse grained, cream-colored to brown, often false bedded, and in some places contains beds of shale interstratified with sandstone. A light sandy soil results from its disintegration. It serves as an excellent reservoir, for the wells that penetrate it usually find in it an abundance of good soft water.

In the part of the State west of Harrison, Boone County, the sandstone is generally underlain by a limestone, 0 to 50 feet thick, known as the Hindsville limestone member. The greatest areal exposure of the member is near Hindsville, Madison County, from which it was named. The limestone is gray, fossiliferous, and oolitic, is interbedded with thin beds of sandstone, and includes at its base a chert-pebble conglomerate. It is suitable for building stone and for making lime. The limestone for the columns at the front entrance of the main building of the University of Arkansas, at Fayetteville, was quarried from this limestone on Brush Creek near Hindsville.

Fayetteville shale.—The Fayetteville shale, 10 to 400 feet thick, consists principally of black or dark-gray carboneous shale, at many places thinly laminated, and in general is thickest to the south. Near its base there is generally a thin bed of hard, dark gray or blue fossiliferous limestone, while its middle part commonly grades from a sandy shale to a true sandstone, and where the sandstone phase predominates this portion of the formation is distinguished as the Wedington sandstone member. The shale is well developed in the valley of West Fork of White River near Fayetteville, from which town it is named, and the Wedington sandstone member is particularly prominent southwest of Fayetteville, in Wedington Mountain, where it attains a thickness of 150 feet—perhaps one-half the total thickness of the formation there. The softness of the shale causes it to erode so easily that its outcrop is usually marked by a valley, or by steep slopes. Where exposed, the shale disintegrates readily and forms a black and fertile soil. The composition of the unweathered shale renders it suitable material for brick making. The shale beds are practically constant from the Oklahoma line to the Gulf Coastal Plain near Batesville, but the sandstone thins out at places.



St. Peter Sandstone, on Buffalo Fork of White River, One Mile East of Mouth of Cove Creek.

Pitkin limestone.—The Pitkin limestone, 0 to 100 feet thick, is widely distributed over Northern Arkansas, extending along the north side of the Boston Mountains from Independence County to the western boundary of the State. It thins out to the north and is generally thickest in its most southern outcrops. It is exposed along the north face of these mountains and on many of their outliers and in some places it forms a prominent escarpment. It is also exposed on the south side of the Boston Mountains in Franklin, Johnson, and Newton counties. It is composed of massive gray fossiliferous limestone, parts of which are probably pure enough for making lime. In the reports of the Arkansas Geological Survey it is known as the "Archimedes limestone," because of the presence of Archimedes, an easily recognized bryozoan, the screwlike stems of which are common on the weathered surface of the rock.

Pennsylvanian Series

Morrow group.—Under the name Morrow group are included several beds of limestone, sandstone, and shale, which vary much in thickness, arrangement, and character, and are of but little topographic prominence. They lie just below the sandstone of the "Millstone grit" of the Arkansas Geological Survey, and, as a rule, form the middle part of the northern escarpment of the Boston Mountains. South of Batesville, near Jamestown, these beds have a total thickness of about 200 feet, while at places farther west they are about 400 feet thick.

To the lower part of the group the name Hale formation has been applied, and to the upper part the name Bloyd shale has been applied. The Hale formation is composed of conglomerate, sandstone, limestone, and shale, and is known to vary in thickness from 80 to 300 feet. The Bloyd shale is composed mainly of black clay shale, but partly of limestone which occurs in two beds, the upper being known as the Kessler limestone member and the lower the Brentwood limestone member. The shale is about 200 feet thick in southern Washington County and northern Crawford County, but from this part of the State it thins to the north and east and is known to be absent in parts of Madison, Carroll, Boone, and Newton counties.

A coal bed, as much as 14 inches thick occurs in the Bloyd shale in Washington County and has been worked on a small scale.

Winslow formation.—The Winslow formation makes the summit and southern slopes of the Boston Mountains, except in the deeper ravines where older rocks have been exposed. Rocks of this formation also occur on the tops of the outliers immediately north of the Boston Mountains.

The formation consists of beds of sandstone and shale, with a few thin local layers of limestone. The sandstone beds range in thickness from 3 feet to more than 50 feet. One of these beds, and in places two, near the base of the formation, are conglomeratic, containing waterworn quartz pebbles of small size and form prominent bluffs along the mountain slopes. These gritty beds at and near the base of the Winslow formation were described by the Arkansas Geological Survey in the report on Washington County as the "Millstone grit." The shales, which constitute probably 75 per cent of the formation, are as a rule black and carbonaceous, though less so than the shales of the Morrow group. Coal occurs within this formation but only in beds too thin to be profitably worked. The Winslow formation in the Boston Mountain region extends up to the base of the series of rocks that contain the workable coal beds in the Arkansas coal field. Its total thickness in the southern part of the region where it is greatest is estimated to be more than 1,500 feet.

Ouachita Mountain Region

CAMBRIAN SYSTEM.

Collier shale.—The Collier shale is exposed in a nearly east-west valley area, 1 to 3 miles wide and about 15 miles long, lying between Womble and Mount Ida, Montgomery County. The entire thickness of the formation is not known as the base is not revealed, but the exposed beds are probably

at least 500 feet thick. The formation is composed mostly of bluish-black soft graphic, intensely crumpled clay shale, but contains some bluish-gray or black limestone and a few thin layers of dark chert. No fossils have been found in the formation. Very little or none of the limestone is suitable for making lime, and none of it is suitable for building stone on account of the fractured condition of the limestone and the occurrence of quartz and calcite veins in it.

ORDOVICIAN SYSTEM.

Crystal Mountain sandstone.—The Crystal Mountain sandstone, 850 feet thick, crops out in Montgomery County and produces high rugged ridges which extend westward from the vicinity of Crystal Springs to a point about 15 miles west of Mount Ida. A group of these ridges south of Mount Ida is known as the Crystal Mountains and from them the sandstone takes its name. The formation is composed of coarse-grained massive gray to brown sandstone but at the base there is a conglomerate with limestone and chert pebbles that have been derived from the Collier shale. Clusters of quartz crystals are found in fissures at numerous places and many are sold at Hot Springs, Garland County, for museum specimens and for use as ornaments. The sandstone is used as a building stone at Mount Ida.

The formation has not yielded any fossils but, for reasons which can not be presented in this short paper, it is tentatively assigned to the Ordovician system.

Mazarn shale.—The Mazarn shale, 1,000 feet thick, takes its name from its occurrence on the headwaters of Mazarn Creek in Montgomery County. It is exposed at other places in this county and outcrops of it are known to extend as far east as Blakely Mountain in Garland County. The outcrops everywhere occur in valleys. The formation consists of shale and of small amounts of limestone and sandstone. The shale is ribboned, consisting of alternating black and green layers that split at an angle with the bedding. Fossil graptolites of Lower Ordovician age have been found at a few places.

Blakely sandstone.—The Blakely sandstone, 0 to 500 feet thick, consists of shale in alternating black and green layers and hard gray sandstone. The shale constitutes 75 per cent of the whole, but the sandstone, which produces high ridges, is the prominent feature. The ridges formed by this sandstone extend in an east-northeastward direction from Womble, Montgomery County, across Garland County, into Saline County. A group of these ridges in Garland County is known as Blakely Mountain and from it the sandstone has been named. The formation is absent at most places west of Womble and at probably all places north of that town. Graptolites of Lower Ordovician age have been found in shale in the formation in Blakely Mountain. Quartz crystals are found in fissures in the sandstone but they are not so numerous as they are in the Crystal Mountain sandstone.

Womble shale.—The Womble shale, 250 to 1,000 feet thick, is exposed in wide and narrow valley areas from the vicinity of Big Fork, Polk County, across Montgomery, Garland, and Saline counties, into Pulaski County. The name for it is taken from the town of Womble, part of which is situated on the base of the shale. The formation consists of black graphitic shale, with thin beds of sandstone near the base and beds of limestone near the top. The shale near the base is composed of black and green layers that split at an angle with the bedding and thus show ribboned cleavage surfaces. Graptolites of Lower Ordovician age are numerous. Some of the limestone has been used for making lime for local use, near Cedar Glades, Garland County, and Black Springs, Montgomery County.

Bigfork chert.—The Bigfork chert is exposed over large and small areas between Shady Postoffice, Polk County, and Pulaski County, and in such areas it produces numerous low steep-sided knobs. The formation is estimated to be 700 feet thick in Garland County and other counties farther west, where it has been studied more extensively than elsewhere. It is composed of thin-bedded gray to black, much shattered chert interbedded with thin layers of black shale. The fossils that have been found consist manly of

graptolites. The chert is excellently adapted for road building and is being used for this purpose at Hot Springs.

Polk Creek shale.—The Polk Creek shale, 0 to 200 feet thick, is exposed on steep rocky slopes and in narrow valleys in close association with the outcrops of the Bigfork chert, and so far as known is absent in comparatively small areas. It is a black graphic shale; in parts it is siliceous and in others clay shale. It has been prospected for roofing slate near Big Fork, Polk County, and near Washita, Montgomery County. Graptolites are abundant in the shale.

SILURIAN SYSTEM.

Blaylock sandstone.—The Blaylock sandstone is exposed in a small area near Bog Springs, Polk County, and in other, though not large areas as far east as the vicinity of Malvern. Along some of its most southern outcrops it has an estimated thickness of 1,500 feet, but it thins so rapidly to the north that it is not present 3 or 4 miles north of the places where it has the above-estimated thickness. It is composed of fine-grained light-gray to dark-gray or green compact sandstone and buff to dark shale. Its areas of outcrop are very rocky, occurring on mountain slopes and in narrow valleys. One small collection of fossils, consisting entiely of graptolites, has been obtained at the south base of Blaylock Mountain, in the southwest corner of Montgomery County.

Missouri Mountain slate.—The Missouri Mountain slate, 0 to 300 feet thick, is exposed on or near high ridges from Polk County east to Pulaski County, but is absent at places near Mount Ida. It is a red and green clay slate but at places is dark colored. Thus far it has not yielded any fossils. It has been extensively prospected for commercial slate at several places near Hawes and Bear, Garland County, and at many places in Polk and Montgomery counties, and has been quarried for switchboards at Slatington, in the last-named county.

DEVONIAN SYSTEM.

Arkansas novaculite.—The Arkansas novaculite is widely exposed in Polk County and the other counties between it and Pulaski County. It is exposed in more or less parallel and nearly eastward-trending belts, whose narrowness is due to the steep dips of the beds. Owing to the narrowness of these belts and to the greater resistance of the novaculite (a variety of chert) to weathering than the adjacent strata above and below, its outcrops stand up as sharp ridges, whereas both the older and younger rocks form valleys. Many rock ledges occur on the crests of the ridges and in the water gaps.

The formation is thickest in its southernmost outcrops, where the thickness at many if not at most places is about 900 feet, but it thins to the north and is absent at places near Mount Ida, and probably at other places. It has been studied more extensively in Garland and Hot Spring counties and the other counties farther west than elsewhere in the State. There it consists of three lithologic divisions—a lower one, made up almost entirely of massive white novaculite; a middle one, consisting mainly of thin layers of dense dark-colored novaculite interbedded with shale; and an upper one consisting chiefly of massive, highly calcareous novaculite. These divisions vary in thickness and character from place to place.

The lower division is commonly from 150 to 300 feet thick, though at some places the thickness is greater. It is made up almost wholly of typical novaculite, whose white color and massiveness make it the most conspicuous part of the formation. In fact, it is this part that usually occupies the crests of the ridges. The beds are from 2 to 10 feet thick and are commonly even bedded. The massive novaculite is usually dense, gritty, fine grained, homogeneous, highly siliceous, translucent on thin edges, and white with a bluish tint, but where unweathered it is bluish gray. It has an uneven to conchoidal fracture and a waxy luster like that of chaledony. Though the bulk of the

rock is white, much of it varies in shades of red, gray, green, yellow, and brown, and in many places it is black. These shades are produced by iron and manganese oxides and possibly in some places by carbonaceous matter. The rock contains a little calcite, but exposures of the calcerous stone are not common and have been found only in stream beds. Joints are numerous and run in all directions, but the most prominent joints are normal to the bedding. Many of them are filled by white quartz veins which are usually so thin as to be inconspicuous. Slickensides along both joints and bedding planes are common.

The middle part of the formation consists chiefly of interbedded novaculite and shale. The novaculite is similar to that in the lower massive part of the formation, except that the common color is dark gray to black and that the beds are much thinner, usually between 1 inch and 6 inches thick. A conglomerate at the base of this division was observed at a number of places. It consists of small rounded and subangular pebbles of novaculite in a sandy and dense flinty matrix. The shale ordinarily observed is black, weathering to a buff or brown color, but some of it is red.

The upper part of the formation ranges from about 20 to 125 feet in thickness and is thickest along the southernmost exposures. It consists chiefly of massive, highly calcareous light-gray to bluish-black novaculite which is so resistent that at some places where it and the accompanying beds of the formation are not overturned it produces low ridges or knobs on the slopes of the higher ridges. Some thin beds of ordinary dense chalcedonic novaculite like that so characteristic of the middle and lower parts of the formation are also included. Fine lamination parallel with the bedding is common. On weathering, the more calcareous rock loses its calcium carbonate becomes white or cream-colored and porous and soft enough to receive impressions from the hammer without breaking.

Novaculite from the lower part of the formation is quarried on North Mountain, Indian Mountain, and near Summit, Garland County, for oil stones or whetstones. It is also quarried on North Mountain, Garland County, and near Butterfield, Hot Spring County, for use in concrete. Deposits of tripoli derived from the novaculite have been prospected near Caddo Gap, Montgomery County and near Langley, Pike County. Manganese oxides occur in the novaculite and much prospecting for manganese ore has been done in Pike, Polk and Montgomery counties.

The lower part of the formation is considered to be of Devonian age; but the middle and upper parts are doubtfully placed in the Devonian system, as there is a possibility that these two parts may be of Mississippian age. The only fossils that have been found in the formation in Arkansas are conodonts, linguloids, sporangites, and fossil wood, all of which were obtained from the middle and upper parts of the formation.

CARBONIFEROUS SYSTEM.

Mississippian Series

Hot Springs sandstone.—The Hot Springs sandstone is exposed on high mountain ridges at and near the city of Hot Springs. It is simply a lenticular formation, and so far as known is not present except near Hot Springs. The maximum thickness is 200 feet. The formation is composed of gray hard quartzitic sandstone, and at the base there is a conglomerate which is as much as 30 feet thick. The pebbles are of all sizes up to 6 inches in diameter and consist mostly of novaculite.

Stanley shale.—The Stanley shale is the surface rock in large and small areas in Polk, Sevier, Howard, Pike, Montgomery, Clark, Hot Spring, and Garland counties, in the southern part of Yell County, in the northern part of Saline County, and in the west-central part of Pulaski County. Some of the largest areas are intermontane basins like the one in which Mena is situated and the one in which the southern part of Hot Springs is situated.

whereas the other large areas form a part of the Athens plateau which is south of the Ouachita Mountains. The thickness, as measured near Glenwood, Pike County, is 6,000 feet, and it is perhaps equally as great at all other places.

The formation is composed of bluish-black and black fissile clay shale and fine-grained compact greenish-gray or bluish-gray sandstone. Several tuff beds, as much as 85 feet thick, occur near the base in Polk County. The upper part of the formation in Arkansas has yielded a single collection of plants including some ferns. Some of the shale at the base has been altered to slate and this has been prospected for commercial slate in Polk, Montgomery, and Garland counties. Quartz veins in the formation contain lead, zinc, and antimony minerals near Gillham, Sevier County.

Jackford sandstone.—The Jackford sandstone, 5,000 to 6,600 feet thick, forms broad low nearly east-west ridges on the Athens plateau south of the Ouachita Mountains. These ridges are forested with yellow pine and among them are Grindstone Mountain extending westward from the vicinity of Arkadelphia, Clark County, and several ridges that are south of Kirby, Pike county. Furthermore, the formation is widely exposed in the Ouachita Mountains themselves. In fact, its outcrops form the highest and some of the most rugged mountain ridges of the Ouachitas. Some of these are Black Fork, Rich, Fourche, Mill Creek, and Irons Fork mountains near Mena, Polk County; Muddy Creek Mountain near Washita, Montgomery County; and Blue Mountain near Cedar Glades, Garland County. In the southern exposures of the formation it is composed of massive compact fine-grained to coarse-grained light-gray sandstone with some mill stone grit, especially in its basal part, and with a small amount of green shale, whereas in many of its northern exposures the shale forms the greater part of the formation and the sandstone a minor part of it. Indeterminable invertebrate fossils have been found in the millstone grit at the base.

Pennsylvanian Series

Atoka formation.—The Atoka formation is exposed in two narrow east-west belts between Kirby and Murfreesboro, Pike County, and another belt, which is probably one of these, follows the south base of Chalybeate Mountain, 5 miles south of Amity, Clark County. The thickness of the formation in this part of the State is estimated to be 6,000 feet. The Atoka is also exposed in large areas in Scott, Yell, and Perry counties and the west-central part of Pulaski County. Two of the principal ridges formed by it are Dutch Creek and Danville mountains. The formation in Yell County is estimated to be 7,800 feet thick. Here, as elsewhere in the State, it is composed of hard light-gray to brown sandstone and an equal or greater amount of black clay shale.

Arkansas Valley Region

CARBONIFEROUS SYSTEM.

Mississippian Series

Jackfork sandstone.—The Jackfork sandstone, as has been previously stated, is composed of shale and a smaller amount of sandstone in its northernmost outcrops in the Ouachita Mountain region, and it is doubtless represented by similar strata in some areas on the south side of the Arkansas Valley.

Pennsylvanian Series

Atoka formation.—The Atoka formation comprises a considerable part of the thick series of sandstones and shales that underlie the coal-bearing rocks in the Arkansas coal field. This series of rocks was referred to in the publications of the Arkansas Geological Survey as the "Lower or Barren Coal Measures." The uppermost formation in this series is known as the Atoka formation and contains beds which are equivalent to part of the Winslow formation of the Boston Mountains. The Atoka is estimated to be about 7,000 feet thick and is composed of sandstone separated by thick beds of

black clay shale. It has not yielded any fossils in Arkansas. The sandstones form ridges and the shales underlie valleys and lowlands. Sandstone beds in the formation supply the gas from the Massard Prairie gas field near Fort Smith, the Coops Prairie gas field near Mansfield, and the Kibler gas field near Van Buren.

Hartshorne sandstone.—The Hartshorne sandstone lies at the base of the productive coal-bearing rocks of the Arkansas coal field. It is known to have a great areal extent, and is found cropping out around the edges of the coal bearing rocks from the east end of the Arkansas coal field westward into Oklahoma. It is 100 to 300 feet thick, and contains minor beds of shale in its central and upper parts. An important coal bed known as the Hartshorne coal rests on the top of the sandstone.

McAlester group.—Above the Hartshorne sandstone there is in the productive coal-bearing rocks a series of shales and sandstones with a number of beds of workable coal. The McAlester group is divisible into three formations—(1) a lower, known as the Spadra shale, consisting of three or more beds of coal and minor strata of sandstone; (2) a middle, called the Fort Smith formation, composed chiefly of sandstone and shaly sandstone beds with one or more workable beds of coal; (3) an upper, described as the Paris shale, consisting partly of beds of sandy shale with some sandstone and one or more workable beds of coal. The Spadra shale is 400 to 500 feet thick, the Fort Smith formation 375 to 425 feet, and the Paris shale 600 to 700 feet. Numerous collections of fossil plants have been obtained from the McAlester group.

Savanna formation.—Overlying the McAlester group there is in the productive coal series a formation consisting of several sandstone members separated by shales. This is known as the Savanna formation. It occurs in Arkansas only in the tops and upper slopes of Poteau, Sugarloaf, Short, and Magazine mountains. That part of the Savanna exposed in Arkansas is estimated not to exceed 1,000 feet, and constitutes approximately the lower two-thirds of the entire formation, which is present farther west in Oklahoma.

The rocks of this formation, as well as the other rocks of the productive coal series, are all more or less folded, so that the shale and sandstone outcrops depend on the character and direction of these folds and can therefore be determined only after a study of the structure of the region. It can be said, however, that the shale outcrops generally lie in the valleys parallel to the ridges which are formed by sandstone.

Gulf Coastal Plain

CRETACEOUS SYSTEM.

Lower Cretaceous Series

Trinity formation.—The Trinity formation is exposed in a belt, a few miles wide, extending from a point near Delight westward across Pike, Howard and Sevier counties and thence into Oklahoma. It has a thickness of over 600 feet at a locality 2 miles north of Center Point, Howard County, and probably has a like thickness farther west in Arkansas, but it thins out near the east border of Pike County. It consists predominantly of clay but includes subordinate beds of sand, gravel, and limestone. The limestone contains fossil oysters and other shells and occurs in two beds, the Dierks limestone lentil and the De Queen limestone member, both of which are exposed in narrow belts. The De Queen limestone, the higher of the two, is near the middle of the formation. It ranges in thickness from a feather edge to 72 feet, and its outcrop extends from Plaster Bluff, near Murfreesboro, westward through De Queen into Oklahoma. It is not present east of Plaster Bluff. The Dierks limestone at some places is 50 feet above the base of the formation and at others is probably 200 feet above the base. Its thickness ranges from a feather edge to 40 feet. Its outcrop extends from a locality about 2 miles north of Delight westward to Cossatot River, where it thins out. The gravel also occurs in two beds that attain

a thickness of 100 feet. The lower of the two gravels is at the base of the formation. It is called the Pike gravel member and is exposed in an almost continuous though irregular belt from the west side of the State to the east end of the outcrop of the Trinity. The upper gravel, the Ultima Thule gravel lentil is above the Dierks limestone and is exposed in an irregular belt extending from Cossatot River westward into Oklahoma. These four lentils and members and the interbedded sands and clays of the Trinity have a slight southward dip. Although the Trinity occupies a nearly horizontal position it rests upon the truncated upturned edges of steeply dipping shales and sandstones of Carboniferous age, which, however, form a smooth floor that has only minor irregularities and undulations. A pronounced unconformity therefore occurs at the base of the Trinity.

The above-mentioned gravels are composed mostly of novaculite pebbles. They are widely distributed and constitute a very large supply of good road material. Gypsum occurs in the De Queen limestone member and has been prospected in a small way near Plaster Bluff. Limestone in this member has been used for rough building stone at De Queen, but neither it nor the Dierks limestone is pure enough for making lime.

Goodland limestone.—The Goodland limestone, 0 to 25 feet thick, is a chalky fossiliferous limestone and is exposed on Little River, near Cerro Gordo, Little River County. It is not exposed east of that place.

Washita group.—The Washita group consists of calcareous clays and thin beds of limestone and is exposed over a small area in the northwest corner of Little River County where it has a total thickness of over 250 feet.

Upper Cretaceous Series

Bingen formation.—The Bingen formation receives its name from the village of Bingen, Hempstead County. Its area of outcrop is a belt, narrow to the east and wide to the west, and extends in a west-southwestward direction from the vicinity of Clear Spring, Clark County, across Pike, Hempstead, Howard, and Sevier counties. The formation ranges in thickness from a feather edge to 580 feet, being thickest to the southwest. It is composed of sand, clay, and gravel, and near Tokio and farther east contains beds to which the name Tokio sand member has been applied. This member is in fact the only part of the formation exposed east of Little Missouri River and is the only part that contains beds of quartz sand.

The gravel in the Bingen occurs in several beds. The southward sloping plateau on which Center Point, Howard County, is located and a similar plateau west of Lockesburg, Sevier County, owe their preservation and prominence to these gravels. The thickest and also the most widely distributed bed which is as much as 60 feet thick, is at the base. These different gravel deposits resemble one another as well as those of the Trinity formation and are well adapted for road making. They are composed of partly rounded to well-rounded pebbles usually 1 inch or less in diameter, and most of the pebbles are novaculite.

Among the other kinds of pebbles there are various types of igneous rocks, which are similar to or identical with some of the crystalline rocks of Arkansas. These are found in the basal part of the formation from the vicinity of Murfreesboro westward.

A greenish cross-bedded arkosic sand composed of kaolinized feldspar and a less amount of other minerals is widely distributed west and northwest of Tokio and Highland. Besides the sand just described the formation contains red, light-colored and dark-colored clays and quartz sand The light-colored clays are in beds reaching a thickness of 5 to 6 feet and consist of plastic ball clays and nonplastic kaolins. A 5-foot bed of kaolin in the NE. ¼SE. ¼ sec. 24, T. 8 S., R. 25 W., is reported to be fullers earth. Some of the clays contain fossil plants.

Brownstown marl.—The Brownstown marl is the surface formation in a belt a few miles wide extending in an east-northeastward direction from the vicinity of Brownstown, Sevier County, to the vicinity of Hollywood, Clark County. In the western part of the belt where it is thickest it attains a thickness of 650 feet. It is a blue or gray calcareous clay containing many fossil oysters and is characterized by the presence of the large oyster Exo-

gyra ponderosa, whence it has sometimes been called the "Exogyra ponderosa marl." The soil derived from the formation, when not mixed with surficial deposits, is black and waxy, but the subsoil is yellow.

Austin ("Annona") chalk.—The Austin chalk consists of white chalk, which at White Cliffs, Sevier County, has a thickness of over 100 feet, but thins out rapidly to the east, disappearing entirely before reaching Okolona, Clark County, where it is composed only of chalky marl. To the west outcrops are found at Rocky Comfort, Little River County. The chalk was formerly used in the manufacture of Portland cement at White Cliffs.

Marlbrook marl.—The Marlbrook marl consists of blue, chalky, somewhat glauconitic marls, which are impure chalk at some places. The most extensive outcrops of this formation are along the ridge which extends from Marlbrook, the type locality in Hempstead County, to Saratoga, in southern Howard County. It forms a stiff, black soil. About 200 to 300 feet above the base of this formation is a very chalky layer 20 to 50 feet thick, which has been called the "Saratoga chalk marl" or the "Saratoga formation." It is exposed in the Marlbrook-Saratoga region at the town of Okolona, where it is called "cistern rock;" at Dobyville, and on Little and Big Deciper creeks in Clark County. The thickness of the Marlbrook marl ranges from 750 feet at Texarkana to 50 feet or less at Arkadelphia.

Nacatoch sand.—Above the Marlbrook marl is a series of sandy beds which are of vast economic importance to a strip of country along the Missouri Pacific Railway between Arkadelphia and Texarkana, since they are the source of the main water supply of that region. Like the other sandy beds of the Cretaceous, at the outcrop they are distinguished with difficulty from the surficial sands that mantle the region. However, the thousands of wells which have been sunk to this horizon prove conclusively that the outcrop of this bed produces the belt of sandy land which begins on Yellow Creek south of Saratoga and extends, with interruptions of greater or less importance, along the main drainage channels, through Washington, De Ann, Garlandville, Nacatoch Bluff, and Keyton, and finally reaches Ouachita River at High Bluffs above Arkadelphia.

Nacatoch Bluff, on Little Missouri River, in Clark County, from which the sand takes its name, reveals one of the most complete exposures occurring along this belt and shows calcareous and quartzitic rocks which, when encountered in wells, are called "water rocks."

In the western part of this region the sands are rather light in color, although about Hope they are overlain by a very black sandy layer 3 to 15 feet thick, and have an aggregate thickness of about 100 to 160 feet. Toward Arkadelphia the sand grows darker and thinner. In the well of the Arkadelphia Ice and Fuel Co. it appears to extend from 100 to 160 feet, and is therefore about 60 feet thick. In a well at Prescott, it is reported to be 176 feet thick. It is apparently 178 feet thick in a well at Bodcaw, Nevada County, and is at least 185 feet thick in a well near Fulton, Hempstead County.

Marls encountered in wells at Little Rock, at Cabot, Lonoke County, and Beebe, White County, contain a fauna corresponding in age to the fauna of the Nacatoch sand. There are small exposures of beds of Upper Cretaceous age in the vicinity of Newark, Independence County, and the meager fauna found in the beds indicate that they are probably of the same age as the Nacatoch sand.

Arkadelphia clay.—The dark laminated clays which overlie the Nacatoch sand form the "blue dirt" of the well drillers along the line of the Missouri Pacific Railway from Arkadelphia to Texarkana. These beds contain uppermost Cretaceous fossils for 100 to 200 feet above the Nacatoch sands, the fossil-bearing beds being well developed on Yellow Creek 3 to 4 miles northwest of Fulton, 5 to 6 miles north of Hope, north and northwest of Emmet, and at Arkadelphia. Thus far no fossils have been found in the upper portion of this formation, which extends without any apparent break to the Eocene sand beds forming the sandy hills south of the Missouri Pacific Railway. This absence of fossils, together with the fact that the Midway

(Eocene) formation, though commonly characterized by limestones, contains dark-colored clays, makes the exact determination of the top of the Cretaceous in this section particularly difficult.

The total thickness of the Arkadelphia clay, excluding the beds which appear to be stratigraphically Eocene, is from 200 to 300 feet at Arkadelphia, 500 feet at Laneburg, 500 to 600 feet at Hope and Spring Hill, and 500 feet at Texarkana.

TERTIARY SYSTEM.

Eocene Series

Eocene deposits, including in ascending order the Midway, Wilcox, Claiborne, and Jackson formation, 1,000 feet or more in aggregate thickness, form the core of Crowley's Ridge; they are exposed in the uplands which occupy much of south-central Arkansas, south of Little Rock; and they are exposed in small areas along the western margin of the Coastal Plain from Little Rock northeastward to the southern part of Independence County. The formations of Eocene age are more or less similar in character, and comprise sands, clays, marls, and some limestones and workable beds of lignite. These beds dip gently to the southeast; they are all more or less sandy; and but few of them are hard and consolidated. At the lignite mines of Ouachita County, however, some of the sands are indurated to very compact sandstones, and at some places in Crowley's Ridge they form the hardest of quartzites. At and near Piggot in Clay County, Benton in Saline County, Malvern in Hot Spring County, Fordyce in Dallas County, Lester in Ouachita County, and other places there are valuable deposits of potter's clay and fire clay.

Pliocene Series

Gravels and sands, possible of Pliocene age, occur in Crowley's Ridge and cover the foothills of Lawrence, Independence, and probably other counties.

QUATERNARY SYSTEM.

A sheet of sedimentary materials, 200 feet or less thick, which consist of sands, clays, and gravels, cover the Tertiary area of the State and some of the adjacent Paleozoic rocks and yield large quantities of water which is extensively used in the culture of rice. The country lying north of Arkansas River and east of the Paleozoic hills belongs mostly to the Quaternary. The lowest strata exposed in Crowley's Ridge belong to the Eocene. All the river bottoms are of recent origin, while the loess, 140 feet or less thick, which caps Crowley's Ridge and likewise the river terraces and second bottoms of all the important streams belong to the Pleistocene.

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The list of reports given below includes only those that were used in the preparation of the above chapter on the topography and geology of Arkansas. These represent a very small percentage of the total number of publications on the geology of the State. A complete bibliography of the geology of the State by J. C. Branner was published in 1894 in Volume 2 of the Annual Report of the Arkansas Geological Survey for 1891, and a second bibliography by him, listing all of the titles up to 1909, was published by the same Survey.

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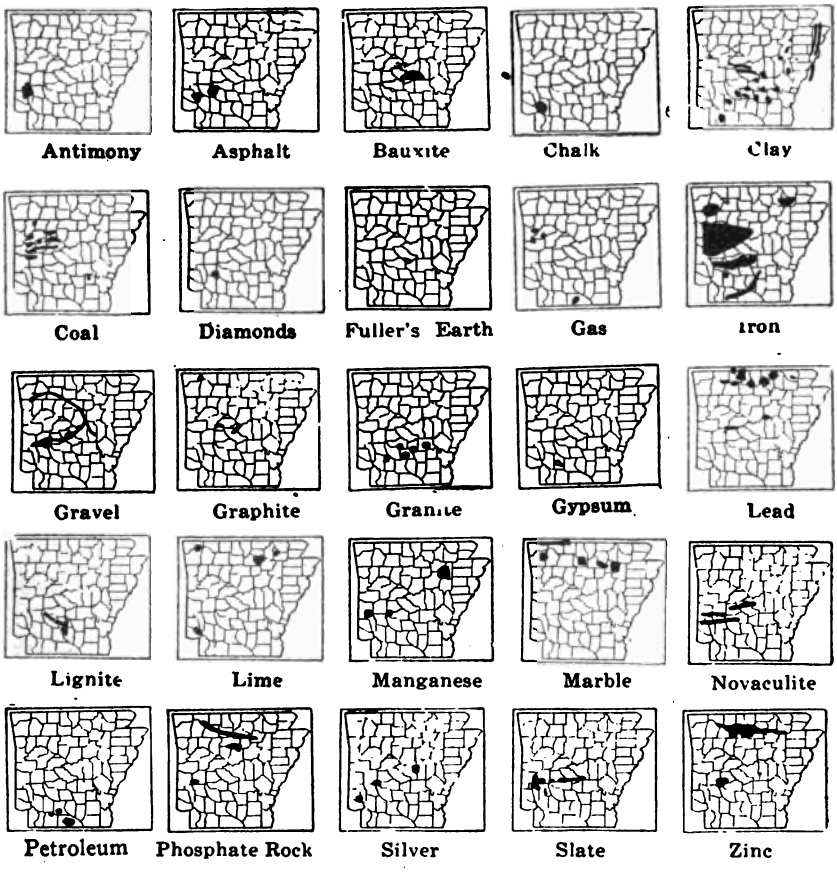
*The numbers in this column are the dates of the publication of the reports.

List of Principal Arkansas Minerals and Their Location by Counties

Miniature Mineral Maps of Arkansas.

NAME	COUNTIES WHERE FOUND
Antimony	Sevier and Howard.
Asphalt	Pike and Sevier.
Bauxite	Pulaski and Saline.
Chalk	Little River.
Clay	General.
Coal	Pope, Johnson, Logan, Yell, Scott, Franklin, Crawford and Sebastian.
Copper	Carroll, Polk and Pulaski.
Diamonds	Pike.
Fullers Earth	Saline.
Glass Sand	Pulaski, Saline, Izard, Jefferson and Greene. Independence, Carroll and Madison.



NAME	COUNTIES WHERE FOUND
Graphite	Hot Spring, Garland, Montgomery and Washington.
Granite	Pulaski.
Gypsum	Pike, Howard and Saline.
Iron	Lawrence and Sharp.
Iron Pyrites	Garland.
Kaolin	Dallas, Garland, Hot Spring, Pike, Saline, Ouachita and Pulaski.
Lead	Baxter, Benton, Boone, Carroll, Marion, Newton, Searcy and Washington.
Lignite	Ouachita, Clark, Dallas and Poinsett.
Limestone	General over North Arkansas.
Manganese	Independence, Izard, Sharp, Pulaski, Montgomery, Garland, Polk, Saline and Hot Spring.
Marble	Boone, Marion, Newton, Searcy, Izard, Carroll, Independence, Lawrence, Sharp and Washington.
Natural Gas	Crawford, Scott, Sebastian, Union and Washington.
Novaculite (Whetstone)	Hot Spring, Garland, Montgomery, Pike and Polk.
Ochre	Drew, Clay and Pulaski.
Petroleum	Union and Ouachita.
Pearls	From Bed of White River and its Tributaries.
Phosphate Rock	Independence, Izard, Stone, Searcy, Baxter, Marion, Newton, Boone and Carroll.
Slate	Pulaski, Saline, Garland, Polk and Montgomery.
Soapstone	Saline, Garland, Hot Spring and Montgomery.
Tripoli	Hot Spring, Garland, Ouachita, Montgomery, Washington and Independence.
Zinc	Baxter, Benton, Boone, Carroll, Marion, Newton, Searcy and Washington.

Counties of Arkansas and Their Mineral Resources

The counties of the State, with their principal minerals, are listed below, the capitalized words indicating the more important minerals:

Arkansas County—Brick clay.

Ashley County—Brick and pottery clay.

Baxter County—LEAD, ZINC, limestone, marbles, phosphate rock.

Benton County—LEAD, brick clay, limestone.

Boone County—LEAD, ZINC, brick clay, limestone, marble, phosphate rock.

Bradley County—Brick and pottery clay.

Calhoun County—Pottery clay.

Carroll County—Iron, LEAD, copper, brick clay, limestone, onyx, phosphate rock.

Chicot County—Brick clay.

Clark County—Marls, brick, tile, fire and pottery clay, lignite, phosphate rock.

Clay County—Brick clay.

Cleveland County—Brick and pottery clay.

Columbia County—Brick and pottery clay.

Conway County—Fire and pottery clay.

Craighead County—Brick clay.

Crawford County—Fire and pottery clay, coal, NATURAL GAS.

Crittenden County—Brick clay.

Cross County—Brick clay.

Dallas County—Fire and pottery clay, kaolin, lignite.
Desha County—Brick clay.
Drew County—Brick and pottery clay, ochre.
Faulkner County—Brick and pottery clay.
Franklin County—Hematite, COAL, fire and pottery clay.
Fulton County—Limestone, phosphate rock.
Garland County—Hematite, iron pyrites, lead, manganese, silver, brick and fire clay, kaolin, graphite, tripoli, novaculite, slate.
Grant County—Pottery clay.
Greene County—Brick and pottery clay.
Hempstead County—Marls, brick, fire and pottery clay.
Hot Spring County—Magnetic iron, lead, manganese, silver, brick and fire clay, kaolin, NOVACULITE, soapstone, tripoli, garnet.
Howard County—Antimony, lead, marls, brick clay.
Independence County—MANGANESE, brick and pottery clay, limestone, MARBLE, PEARLS, PHOSPHATE ROCK, tripoli.
Izard County—Lead, manganese, glass sand, limestone, phosphate rock.
Jackson County—PEARLS.
Jefferson County—Brick and pottery clay, glass sand.
Johnson County—Fire and pottery clay, COAL.
Lafayette County—Pottery clay.
Lawrence County—Iron, brick clay, kaolin, limestone, PEARLS.
Lee County—Brick and tile clay.
Lincoln County—Brick clay.
Little River County—CHALK, clays for cement.
Logan County—Iron pyrites, fire and pottery clay, COAL.
Lonoke County—Brick clay.
Madison County—Limestones, mable.
Marion County—LEAD, ZINC, limestone, marble.
Miller County—Brick and tile clay.
Mississippi County—Brick and tile clay.
Monroe County—Brick and tile clay, PEARLS.
Montgomery County—Gold (sparingly); hematite, lead, manganese, pottery clay, graphite, soapstone, tripoli, novaculite, barytes, SLATE.
Nevada County—Brick, tile and pottery clay.
Newton County—LEAD, ZINC, limestone, marble.
Ouachita County—Fire and pottery clay, kaolin, tripoli, LIGNITE.
Perry County—Coal, brick clay, gravel.
Phillips County—Brick and tile clay.
Pike County—Hematite, manganese, silver, ASPHALT, marls, ball or paper clay, fire clay, DIAMONDS, KAOLIN, gypsum, lignite.
Poinsett County—Brick and tile clay, lignite.
Polk County—Copper, iron pyrites, manganese, brick clay, novaculite, SLATE.
Pope County—Brick clay, COAL.
Prairie County—Brick clay, pearls.
Pulaski—County—Bauxite, copper, hematite, lead, manganese, silver, kaolin, brick and pottery clay, GRANITE, ochre, slate.
Randolph County—Brick clay, PEARLS.
Saline County—BAUXITE, hematite, iron pyrites, manganese, silver, brick, pottery and fire clay, KAOLIN, FULLERS' EARTH, glass sand, SOAPSTONE.
Scott County—COAL, NATURAL GAS.
Searcy County—Iron pyrites, LEAD, ZINC, brick clay, limestone, marble, phosphate rock.
Sebastian County—COAL, NATURAL GAS, brick, fire and pottery clay.
Sevier County—ANTIMONY, lead, silver, asphalt, marls, brick and cement clay.
Sharp County—Manganese, iron, limestone.
St. Francis County—Brick and tile clay.
Stone County—Phosphate rock.
Union County—Brick and pottery clay, NATURAL GAS, PETROLEUM.
Van Buren County—Building stone.

Washington County—Lead, brick clay, limestone, natural gas, oil shale, tripoli.
White County—Brick, fire and tile clay.
Woodruff County—Brick and tile clay, PEARLS.
Yell County—Brick and pottery clay, COAL.

MINERALS AND ECONOMIC PRODUCTS

Arranged Alphebetically

Actinolite

Magnesium-calcium-iron silicate (Amphibole).—Occasional in granitic rocks. Magnet Cove.

Aegirite

Aluminum-calcium-iron-soda silicate—near phyroxene, with alkalies; in granitic rocks, with labradorite; also enclosed in microline. Magnet Cove.

Agalmatolite

In pockets in shale, and as "selvage" in quartz seams; Saline County; Garland County; commonly; generally distributed in other counties.

Agarie Mineral

Fine powdery incrustations on rocks or in crevices; coating of silvery shale, Montgomery County; in Peacock lode, Logan county.

Agate

Finely variegated Montgomery County.

Agricultural Marls

It is very remarkable that in Arkansas, within a small triangular area of thirty miles square between Washington and Murfreesboro and the White Cliffs of Little River we have abundant supplies of at least four of these valuable kinds of marl, greensand, lime, chalk and gypsum with the reasonable expectation that another year's investigation would reveal the phosphates. These facts alone, if properly utilized, will be of greater value to the state than all the gold dug within the bounds of California has been to that state.

These marls are very siliceous, and the lime and greensand occur in local horizons or beds. Their chief value, if used for mixing, would be to loosen and supply phosphoric acid, iron and potash to sandy and sticky clay lands. * * * The potash in these marls is 3.06 parts in the 100. The lime can be regulated by selecting the fossiliferous or non-fossiliferous portions. The chief point of occurrence of these green sands is in the valley of Town Creek at Washington, Hempstead County, where the greensand occurs in varying degrees of purity, accompanied or unaccompanied by shell beds, which are useful in case lime is also needed. The same greensands occur in Clark County at many places, but as far as the writer's limited observations extend, in no case, so pure as those at Washington. The sandy surface

residual soils of these marls, occupying an intermittent and limited strip from Arkadelphia to Columbus, are, no doubt, the finest soils possible for fruit trees and especially valuable for growing peaches. In this connection it is interesting to note that they present the same physical condition and occupy the same geolgoic horizon as the celebrated peach growing regions of New Jersey.

The lime marls of the middle beds of the upper Cretaceous in Clark, Hempstead, Southern Howard and Sevier counties are of great variety in composition, inexhaustible in quantity, and must be a source of great wealth to the agricultural industries of this part of the state in the future. The principal geologic horizons of these marls are the beds between Washington greensands and the White Cliffs chalk, including the Big Deciper, Gryphaea vesicularis and Exogyra ponderosa marls, at innumerable places wherever these are the surface formations. The noted Cretaceous black lands are without exception, the immediate residue, or but slightly transported debris, of these formations.

The essential ingredients in all of these lime marls are calcium carbonate, usually in a chalky state of division, phosphoric acid and potash; the accessory ingredients, which would be noted in comparison with the soil to be treated, are sand and clay. Greensand is usually more or less abundant throughout. In general, these lime marls possess, in addition to all the virtues of greensand marls above described, a large and valuable percentage of the form of lime known as calcium carbonate.

REFERENCES

Branner, John C.—Annual Report Ark. Geol. Surv. Vol. II, 1888.

Albite

Sodium-aluminum silicate. (Feldspar).—Sparingly in granitic rocks. Magnet Cove.

Allophane

Hydrous aluminum, silicate. Incrustations in crevices, etc. Magnet Cove.

Almandite

Iron-aluminum silicate. (See Garnet).—Crystals abundant in wash, also in granitic rocks. Magnet Cove

Aluminite

This, or a closely allied earthy mineral in Tertiary clays; Pulaski, Saline, Hot Spring, Pike, Sevier and Polk counties, and northward.

Alunogen

Reported by Purdue from Searcy County.

Ankerite

Calcium-magnesium-iron carbonate. In seams, crevices, etc., and in larger masses, in calcerous rocks; shades into dolomite and calcite. Magnet Cove.

Antimony

Since 1873 antimony has been mined intermittently in Sevier and Howard counties, near Antimony and Gillham. This field is believed to extend westward into Oklahoma.

The rocks of the antimony region are alternating thinly bedded sandstones and sandy or muddy shales, of Pennsylvanian and Mississippian age. They are of a light-yellowish or drab color where exposed, and dark gray to black where unweathered. The rocks have been thrown into very regular parallel folds running a trifle north of east. The folds are so close that

in many places the dip of the rocks approaches perpendicularity, and so regular that the strike of the rocks is sometimes used to tell direction.

The ore bodies occur in thin lenticular masses whose longest dimension approaches verticality and may reach more than 100 feet. The width may be from 3 or 4 feet to 20 or even 40 feet; the thickness ranges from a "feather-edge" to 2½ feet.

REFERENCES

Hess, F. L.—The Arkansas antimony deposits. Bulletin No. 340, U S Geol. Surv., Washington, 1908.

Apatite

Calcium phosphate and chloride (or fluoride). In crystalline rocks, also associated with dolomites. Magnet Cove.

Aplome

Part of the common iron garnet is in this form. Magnet Cove.

Aprodite

In beds or masses; Pulaski and Garland counties.

Aragonite

Occasionally as "flos-ferri" in iron ore deposits; distribution general, though not abundant.

Arkansite

One of the rare minerals found in Magnet Cove, which has attracted wide attention among students of geology, is Arkansite (Titanic acid or Brookite). It is in the form of thick black crystals and is much sought after by collectors of mineral specimens, but has no particular commercial value. Its characteristics and geological significance is discussed in numerous papers and publications of a scientific nature.

REFERENCES

Shepard, Charles Upham.—On three new mineral species from Arkansas. American Journal of Science, second series, Vol. LII. Arkansite, Ozarkite and Schloromite, New Haven, 1846.

Asbolite

Sparingly in pockets or crevices among shales and intrusive rocks; Ouachita River, south of Hot Springs; possibly in Montgomery county also.

Asphalt

There are seven asphalt deposits, three of which are in Pike County, and four in Sevier County, in Southwestern Arkansas, which have been examined. The asphalt deposits in Pike County are near Pike, Delight, and Murfreesboro. The deposits in Sevier County are between Dierks and DeQueen, near the village of Lebanon.

The asphalt impregnates nearly horizonal beds of loose sand in the basal part of the Dierks limestone lentil or still lower in the Trinity formation. The deposits thus consist of asphaltic sand except at one place where the asphalt impregnates the Pike gravel member at the base of the formation. The layers containing the asphalt range from an inch to 12 feet in thickness.

The asphalt deposit near Pike is the only one from which asphalt has been shipped in commercial quantity. The asphaltic sand mined at that locality from 1903 to 1906 by the Arkansas Asphalt Company is said to have amounted to 4,815 tons, valued at $22,368. It was used in Little Rock in paving West Markham Street from Main to Cross streets, a distance of 12 blocks, and in paving part of Center Street. A 2-inch surface of the asphalt was laid upon a 5-inch concrete base, which rested upon clay. Owing to improper preparation of the asphalt the paving was not entirely satisfactory.

HOW TWO VALUABLE MINERALS ARE MINED IN ARKANSAS

Bauxite Mine at Bauxite, Ark.

Manganese Mine, Independence County.

The asphalt deposit near Delight is thin, the reported thickness being 3 to 6 feet. If the deposit is later proved to maintain that thickness under a considerable area, it might be profitably worked, but the overburden is so thick, 30 to 35 feet or more, that underground mining would probably be necessary. The asphalt exposed at the other localities is not thick enough to be mined and probably is no thicker away from the outcrops.

REFERENCES

Miser, Hugh D. and Purdue, A. H.—Asphalt deposits and oil conditions in Southwest Arkansas. U. S. Geol. Surv. Bulletin 691-J, 1918.

Augite

Aluminum-mangesium-calcium-iron silicate (Pyroxene). In basic igneous rocks. Magnet Cove.

Aventurine Quartz

Quartz spangled with scales or other mineral; intercalcated with black shales; Micaceous. Magnet Cove.

Barite

Scattering deposits in Pike, Polk, Pulaski, Saline, Garland and Montgomery counties.

Bartholomite

Incrustation in crevices as result of decomposition of pyrite; probably some of the red copperas, as at Rabbit Foot mine, Saline County, is this or the allied mineral, Botryogen.

Basanite

In beds, much jointed, in axes of uplifts; Pulaski County.

Bauxite

Arkansas' bauxite production has increased so rapidly that since 1910 the State has produced over 80 per cent of the bauxite mined in this country. In 1915 the output was more than 90 per cent of the total and has continued at this rate to the present time.

The only operators of importance in 1920 are the Republic Mining and Manufacturing Company of Little Rock; the American Bauxite Company of Bauxite; the Globe Bauxite Company of Chemical Spur; and the Du Pont Chemical Company of Wilmington, Delaware.

The major part of the production comes from what is known as the Bauxite District, sometimes called the Bryant District, lying about 18 miles southwest of the city of Little Rock and covering an area of about 12 square miles in Bryant township of Saline county. The second and less important district is known as the Fourche Mountain District, lying immediately south of the city limits of Little Rock in Pulaski County and embracing an area somewhat larger than the Bauxite District. The two areas are about 14 miles apart.

Arkansas produced, in 1920, 481,279 long tons, as compared with a total domestic production of 521,308 tons of the value of $3,247,345.

Estimates of the quantity of bauxite ore obtainable in the Arkansas field range from 5,000,000 tons, by John T. Fuller, superintendent of the American Bauxite Company, to 50,000,000 tons, by Dr. Chas. W. Hayes of the U. S. Geological Survey. It is probable that the amount of ore that will be mined will be somewhere between these extremes.

Bauxite Production in Arkansas by Years.

Year	Long Tons	Year	Long Tons	
1899	5,043	1910	*115,836	
1900	3,445	1911	*125,448	
1901	867	1912	*126,105	Value
1902	4,645	1913	169,871	$ 846,988
1903	25,713	1914	195,247	976,686
1904	25,748	1915	268,796	1,370,489
1905	32,956	1916	375,910	2,011,590
1906	50,267	1917	506,556	2,724,007
1907	* 63,505	1918	562,892	3,133,880
1908	* 37,703	1919	333,490	1,855,159
1909	*106,874	1920	481,279	2,897,892

*Including small productions from Tennessee.

REFERENCES

Hayes, C. W.—"The Arkansas Bauxite Deposits," 21st Annual Report, U. S. Geol. Survey., pt. 3, 1901, pp. 435-472.

Mead, W. J.—"Occurrence and Origin of the Bauxite Deposits of Arkansas," Economic Geology, Vol. 10, No. 1, January, 1915.

Biotite

Sparingly in granitic rocks.

Braunite

Manganese sesquioxide and silicate. In veins or intrusions. Magnet Cove.

Breunerite

Iron-magnesium carbonate; shading off into ankerite and dolomite, in similar situations; distribution irregular.

Brookite

Titanic acid. See Arkansite. (Var.) See Psuedobrookite, occasional reddish or hair-brown crystals as "float," but Arkansite is most common. Magnet Cove.

Brucite

Hydrous magnesium oxide; occasional in masses of serpentine; Saline County.

Cement Materials

Inasmuch as clays occur in almost every part of the state in greater or less abundance, it is assumed that the location of the chalk, at White Cliffs, must determine the site of a possible cement factory. A special effort has therefore been made to ascertain whether the clays at and near the chalk deposits are available for the production of cement. Little River and Sevier County clays are intimately associated with the post-tertiary gravels, and cover large portions, not of Little River and Sevier Counties alone but of several of the adjoining counties in the Southwestern part of the state.

The proximity of the natural gas field of Southern Arkansas and Northwest Louisiana to the White Cliffs chalk deposits affords an additional advantage for the utilization of the abundant supply of materials in Southwest Arkansas for the manufacture of cement.

"Limestone suitable for Portland cement occurs in many counties in the northwestern part of the state."—U. S. Geol. Surv. Bull. 624.

REFERENCES

Branner, John C.—On the manufacture of Portland cement. Annual Report of the Geol. Surv. of Arkansas for 1888, Vol. II, Little Rock, 1888. Contains tables of analyses of Arkansas chalks and clays.

"The Cement Materials of Southwest Arkansas." Transactions of the American Institute of Mining Engineers, 1897, Vol. XXVII, 5 cuts and map.

Reply to criticism of R. T. Hill, on "The Cement Deposits of Arkansas." Transactions American Institute of Mining Engineers, Vol. XXVII, New York, 1897.

Eckel, E. C.—Portland Cement Resources of Arkansas. Bulletin No. 243, U. S. Geol. Surv., Washington, 1905.

Fitzhugh, G. D.—The Portland cement materials of Southwestern Arkansas. Engineering Association of the South. Transactions, Vol. XV, 1905.

Hill, Robt. T.—Criticism of the paper of J. C. Branner on "Cement Deposits of Arkansas." Transactions of the American Institute of Mining Engineers, Vol. XXVII.

Chalcopyrite

Sevier County, west of Gillham; not mined.

Chalk

The chalk deposits of the state, so far at least as the Geological Survey has been able to outline them, are confined to Little River County. It is highly probable, however, that similar or more or less modified deposits may be yet found in adjacent counties along the northeastern extension of the outcrop. The chalk is exposed at and about the village of Rocky Comfort and at and about White Cliffs Landing on Little River. The most extensive exposures are those about Rocky Comfort where the chalk and black soil derived from its decomposition cover an area of about twenty square miles. The chalk and the chalky limestones extend further north and further east than they are represented * * * but they are covered in those directions by superficial post-tertiary deposits of clay, gravel and sands to depths which would probably render their handling unprofitable. Even the derived black soil is itself too thick in many places to admit of removal. The area over which the chalk is actually exposed and without covering about Rocky Comfort is estimated to be only about 900 acres.

The value of this chalk is hardly appreciated at the present time. When we consider that chalk is a very soft rock, and therefore, does not require grinding as do the compact limestones, and further the greater ease with which it can be burnt to lime, its superiority over other limestones may be seen. The fact that this bed is the only one known to exist in the United States may increase its value. * * These cliffs which long have been a landmark of the region, are about 150 feet high, perpendicular, and as white and almost as pure as the celebrated chalk cliffs of Dover, England. * * * The following analyses show how closely it agrees in composition with the chalk of Medway, England, which has been so long used in the manufacture of Portland cement:

	Medway, England.	Rocky Comfort.	White Cliffs.
Carbonate of Lime	88.50	88.48	90.32
Carbonate of Magnesia	....	....	Trace
Iron Oxide	1.05	1.25	6.85
Alumina	2.82	1.25	1.30
Alkalies	2.61	....	None
Silica	5.45	9.77	6.85

REFERENCES

Branner, John C.—Reports Arkansas Geological Survey, Vol. II, 1888, and Vol. IV, 1890.

Marcou and Belknap.—Jura, Neocomian and Chalk of Arkansas. American Geologist, Vol. IV, pp. 357-367, December, 1889.

Anonymous.—Chalk of Southwestern Arkansas. Stone, April, 1902, Vol. XXIV, New York, 1902.

Taff, J. A.—Chalk of Southwestern Arkansas, with notes on its adaptability to the manufacture of hydraulic cement. Twenty-second Annual Report of the U. S. Geol. Surv., Part III, Washington, 1902.

Chrysolite

In crystals and disseminated grains in igneous and metamorphic rocks, some peridotites; Fourche Mountain and northwestwards; Pulaski and Saline counties; Murfreesboro and in Magnet Cove.

Celestite (Strontium Sulphate)

Howard, Pike, and Sevier counties, as thin layer in lower Cretaceous limestone.

Cinnamon Stone

In float and in metamorphic rocks. Magnet Cove.

Clays

The Tertiary clays are the most important in the state. With their accompanying sands, marls and organic deposits, they underlie a large part of the state east and south of the Missouri Pacific Railway, south of Arkansas River. North of this and east of the Paleozoic hills the sediments are chiefly Quarternary deposits, except Crowley's Ridge, the lowest part of which is Tertiary.

Limonite hardpan, or buckshot, is found all over the low country for 50 miles or more west of Crowley's Ridge. On the east of the ridge it is but a narrow fringe along its base below Poinsett county, but north of this county it spreads over the whole region as a subsoil, in places rising to the surface and varying in depth from 3 to 7 feet. It extends eastward to the alluvial bottoms of the St. Francis. Along the Cache River in Greene and Clay counties much of the land is made up of these slashes or buckshot soil.

In the low, flat lands, commonly known as "slashes," thin beds of plastic clays are found at places where acidulated waters have leached the iron from the soil. Some small potteries get their clays from such places. The supply of available clays of this kind is uncertain, and most of the areas covered by them are small. Such clays occur in the flat lands of the Cretaceous, Tertiary and Quarternary areas of the state, which, are not alluvial lands, properly speaking.

Sebastian county is among the leading counties of the state in the development of its clay industries. Clay shales of the coal-bearing rocks are used in the manufacture of paving bricks

The abundance of excellent raw materials, the proximity of the deposits to the coal and gas fields and ample transportation facilities have encouraged development, giving the county high rank in the output of clay products.

Clays For Drain Tiles.

There is no lack of clay in this state available for the manufacture of good drain tiles. The light-blue clays through the country lying between Beebe and Kensett and thence to Judsonia, and between Kensett and West Point, in White county, are available for the manufacture of tiles. The clays about Brinkley, Monroe County, are well adapted to tile making. Along the western base of Crowley's Ridge in Phillips, Lee and St. Francis counties, and on both sides of the ridge in Cross, Poinsett, Craighead, Greene and Clay counties, these clays are abundant and of excellent quality. They abound also along Bradshaw and Terre Noir creeks in Clark County. In the counties south and southeast of Little Rock, clays available for tile making occur both as surface soils in the valleys (not alluvial) and in the widespread stratified Tertiary beds of the region.

Fire Clay

"Fire clays occur under nearly all the beds of lignite wherever they have been found in Crowley's Ridge. At the base of the great beds on Bolivar Creek in Poinsett county, are found clays rich in alumina and which might be of good quality. In Northern Arkansas the Eureka shale is present in large quantities." Fire brick are manufactured at Malvern and Camden from clays of excellent quality.

Kaolins or Pottery Clays

Deposits of kaolin occur at many places and in a variety of formations. The best known deposits are those of Saline County, near Benton from which the famous Niloak (a reversed spelling of kaolin) pottery is made. The beauty and popularity of these wares are due as much to the skill of the

artists as to the quality of the material from which the pottery is made though the texture of the clay and its colors are important factors in ceramic art. No two pieces of this pottery are alike in arrangement of color. Two or more shades are employed, usually a blue and a brown, in interesting rotation and accidental pattern. No less attractive are the truly artistic designs by which the clay is shaped into vases, bowls, urns and all manner of nicknacks, such as ornament the library table or mantel.

"The kaolins found in Saline county are of three varieties: (1) a compact variety, derived from the feldspathic rocks by decomposition, (2) a pisolitic variety, found associated more or less intimately with the bauxite deposits, and (3) a clay-like variety of sedimentary origin, found at Benton." The report indicates extensive deposits in this locality.

The Pike County kaolin is different in physical characters from any other kaolin thus far found in the state. * * * The largest area found in any one body covered about 10 acres. No exposures of feldspathic rock are within 50 miles of the deposit. * * * The greatest depth at which the kaolin was found was 25 feet.

A white kaolin of fair refractoriness outcrops on the Kilmer land in Dallas County and a quantity is reported on Sandy Branch in Ouachita County. Of the latter deposit Doctor Branner says: "After the sand is removed by washing it is available for the manufacture of pottery and also as a refractory material. The quantity seems to be very large." The kaolin deposits in Magnet Cove are not considered of commercial importance.

REFERENCES

Branner, John C.—The clays of Arkansas, Bulletin 351, U. S. Geol. Surv., 1908.

Purdue, A. H.—Possibilities of the clay industry of Arkansas, published by the Arkansas Brickmakers' Association, 1910.

Coccolite

Variety of lime-magnesia, pyroxene (Malacolite); in granitic rocks. Magnet Cove.

Copper

There is no record of copper ore production in Arkansas, although scattering deposits have been discovered in several places and mined on a small scale, principally in North Arkansas, at one place in Pulaski County and in Polk County.

Purdue reported the presence of chalcocite of steel-gray or blackish type from Carroll County, and it is reported that ore is being mined near Eureka Springs. Chrysocolla is frequently found in cavities at the zinc mines. Aurichalcite is also common at many of the zinc mines, but always in small quantities.

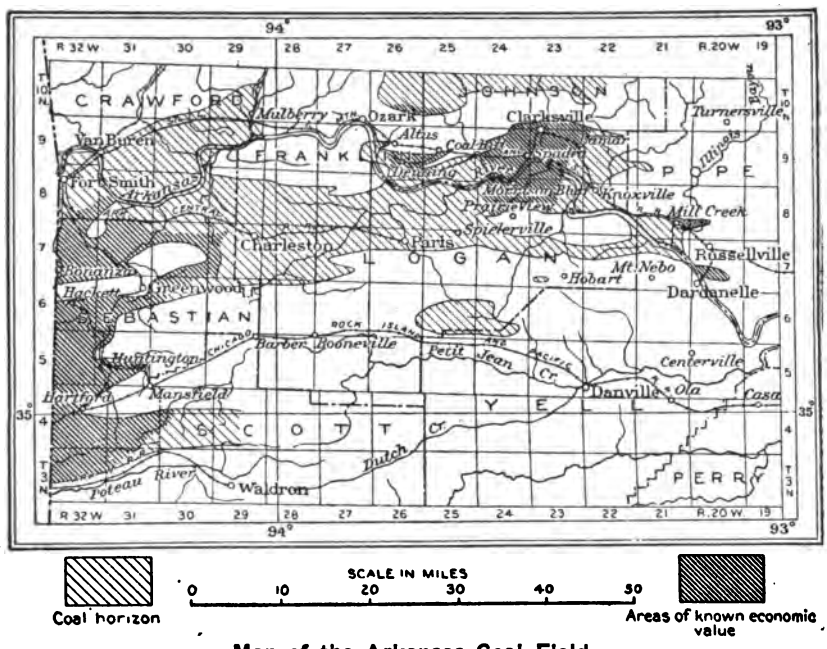
The only economic source of copper as yet made manifest is the mineral chalcopyrite, or copper pyrites, which is intimately associated with galena in nearly all of the known occurrences of that mineral. (In Pulaski, Polk, Howard, Sevier, and Montgomery counties).

REFERENCES

Branner, John C.—Report Ark. Geol. Surv., Vol. V, 1892.

Copperas

Iron sulphate. (Malenterite), strictly, but blue vitrol (Chalcanthite) is included popularly; Melanterite appears to be more abundant than chalcanthite.



Map of the Arkansas Coal Field.

Coal

The coal-bearing area of the state is 1584 square miles in extent. The field reaches from Russellville on the east through Pope, Johnson, Logan, Yell, Franklin, Crawford, Sebastian and Scott counties to and beyond the Oklahoma border.

About Clarksville and Russellville in the eastern part of the field, the product is a high-grade semi-anthracite and in the western part of the field is produced a high-grade semi-bituminous coal of almost smokeless quality.

Varying widely in character, the Arkansas coals will prove of their greatest utility, when the differences of quality are more properly emphasized in the trade and employed for the specific uses to which each type of fuel is especially adapted, for a coal that is remarkably well adapted to one purpose may be ill-fitted for another. The semi-anthracite is preferable for domestic use, because of its cleanliness, and the semi-bituminous is more suited to steaming purposes in locomotives or factory furnaces, because of its high-heat-producing qualities.

Extent of the Coal Supply

The Arkansas coal field lies in the valley of the Arkansas River between the western border of the state and Russellville. It has roughly the shape of a Roman capital L with its base along the Oklahoma line. It is about 33 miles wide and 60 miles long, but it is only in the eastern and western parts of this area that the Hartshorne coal is probably thick enough or sufficiently free from partings to be of economic importance. Still, some 300 to 320 square miles will probably contain coal which may be mined. In places, the coal is over 8 feet thick, and when clean and of good quality, it has been mined where no thicker than 18 inches. The Hartshorne seam will probably average about 3 feet thick, and assuming this thickness over 310 square miles, that part of this bed which lies in Arkansas once contained something like a billion and a quarter tons of coal. The small amount of coal above and below the Hartshorne horizon may be nearly equivalent to that already mined, which was about 46,800,000 tons up to the end of 1919.

At an average "recovery" of 80 per cent in mining, the state will therefore yield only about 850,000,000 tons, but at the present rate of mining, this will last for 350 years. The rate of mining will probably increase.

Heating Value of Arkansas Coal.

The coals in the eastern part of the field have about seven to nine times as much fixed carbon as volatile combustible matter, and are rated as semi-anthracite. These are sold for domestic use at but little below the price of the Pennsylvania anthracite. Those in the western part of the field contain but three to six, generally five, times as much fixed carbon as volatile combustible, and the coals are bituminous. They are less smoky than most bituminous or soft coals.

The heating value of the coal, which lies between 13,700 and 14,700 British thermal units, and its specific gravity (average 1.35) place it among the best coals in the United States. Its moisture and ash are also low, but it contains a little more sulphur than other high grade coals.

Representative Analyses of Arkansas Coals

(U. S. GEOLOGICAL SURVEY)

	Russellville	Paris	Hartford	Jenny Lind
Moisture	2.07	2.41	2.89	1.60
Volatile Matter	9.81	17.23	19.29	17.40
Fixed Carbon	78.82	70.35	67.34	73.09
Ash	9.30	10.01	10.48	7.91
Sulphur	1.74	3.21	1.10	1.42
B. t. u.	13702	13523	13271	14162
	Huntington	Bonanza	Spadra	Denning
Moisture	3.53	1.99	3.12	3.64
Volatile Matter	16.66	15.90	11.39	15.32
Fixed Carbon	72.04	75.05	77.03	73.88
Ash	7.77	7.06	8.46	7.16
Sulphur	1.29	1.05	1.84	2.43
B. t. u.	14017	14087	13793	13743

Mine Face Samples of Arkansas Coal

The analyses give "as received" values—that is, the analysis shows the character of the sample as it is received at the laboratory in an air-tight container sealed in the mine.*

	Lab. No.	Moisture	Vol. Matter	Fixed Carbon	Ash	Sulphur	B. T. U.
SEMI-ANTHRACITE.							
Pope County							
Russellville	18755	2.79	11.90	75.24	10.07	2.17	13,356
Spadra	2587	3.12	11.39	77.03	8.46	1.84	13.793
SEMI-BITUMINOUS							
Franklin County:							
Denning	1042	.84	16.46	75.32	7.38	1.91	14,645
	18746	3.24	15.19	74.01	7.56	2.27	13,756
Logan County							
Paris	3174	2.77	14.69	73.47	9.07	2.79	13,774
	18750	2.48	17.11	70.58	9.83	3.29	13,496
Sebastian County							
Bonanza	2599	1.99	15.90	75.05	7.06	1.05	14,087
Greenwood	3173	3.21	14.84	72.66	9.29	3.12	13,588
Huntington	1045	1.02	17.88	73.61	7.49	1.10	14,434
Hackett	18062	3.55	15.73	65.56	15.16	1.67	12,541
BITUMINOUS							
Scott County							
Bates	3505	3.37	24.44	66.40	5.79	.87	.....

LIGNITE

Ouachita County							
Lester	2647	39.50	25.35	22.57	12.58	.53	5,877

*Analyses are from Pp. 47-51, U. S. Bureau of Mines Bulletin 22, 1913, or from Pp. 29 and 30, U. S. Bureau of Mines Bulletin 123 (18750, 18755, 18062, 18746), 1918.

Analyses of Coals of Pennsylvania, West Virginia, Illinois and Kansas.

ANTHRACITE

	Lab. No.	Moisture	Vol. Matter	Fixed Carbon	Ash	Sulphur	B. T. U.
No. 1, Pennsylvania	5954	2.80	1.16	88.21	7.83	0.89	13,298

SEMI-BITUMINOUS

No. 2. (Pocahontas) West Virginia	Avg.	3.26	13.95	78.33	4.45	0.56	14,950
BITUMINOUS							
No. 3, Pennsylvania	4352	2.01	33.56	58.11	6.32	1.39	14,441
No. 4, Herrin No. 6 Coal, Ill.		9.21	34.00	48.08	8.71	1.53	11,825
No. 5, Kans. Coal	23238	25.49	26.07	43.95	4.49	.71	8,788

No. 1 U. S. Bureau of Mines Bulletin 22—p. 172.

No. 2 West Virginia Geol. Survey—Wyoming, McDowell Counties, 1915, p. 730.

No. 3 U. S. Bureau of Mines Bulletin 22, p. 183.

No. 4 Ill. State Geol. Survey, Coop. Coal Mining Series Bull. 16, Plate III, 1917.

No. 5 U. S. Bureau of Mines Bull. 123, p. 39.

Directory of Arkansas Coal Mine Operators

SEBASTIAN COUNTY.

Actus Coal Co. Mine No. 1, one and one-quarter miles west of the station. Jenny Lind; railroad connections, Iron Mountain; slope opening; C. C. Woodson, general manager. Huntington; C. R. Dewberry, mine foreman, Jenny Lind.

Big Vein Coal Co., Smedley mine; three and one-half miles northeast of Hartford; railroad connections, Midland Valley; slope opening; W. E. West, president and general manager; Roy Smith, foreman.

Back Bone Coal Co., Jones mine; two miles south of Excelsior; shaft opening; 70 feet deep; railroad connections, Midland Valley; M. K. McCubrey, superintendent and general manager, Greenwood.

Central Coal & Coke Co., mine No. 2; one-half mile north of station, Huntington; shaft opening; 42 feet deep; railroad connections, Frisco; Harry Risher, superintendent.

Central Coal & Coke Co., mine No. 3; three miles west of Huntington; shaft opening; 123 feet deep; railroad connections, Frisco; Harry Risher, superintendent; Ernest Gurth, foreman.

Central Coal & Coke Co., mine No. 4; one-quarter mile south of station, Hartford; slope opening; railroad connections, Rock Island; Robert Boyd, Jr., superintendent; Walter Milan, foreman.

Central Coal & Coke Co., Mine No. 6; three and one-half miles west of Huntington; shaft opening; 267 feet deep; railroad connections, Frisco; Harry Risher, superintendent; Joseph Porter, foreman.

Central Coal & Coke Co., Mine No. 10; one-quarter mile west of Hartford; slope opening; railroad connections, Rock Island; Robert Boyd, Jr., superintendent; J. W. Fitzjarrell, foreman.

Central Coal & Coke Co., mine No. 11; three miles northeast of Hartford; shaft opening, 254 feet; railroad connections, Midland Valley; John McCury, superintendent; Joseph Angerer, foreman.

Central Coal & Coke Co., mine No. 15; one-half mile northeast of station, Hartford; slope opening; railroad connections, Rock Island; Robert Boyd, Jr., superintendent; John Bates, foreman; William Harkes, general manager; Keith & Perry Bldg, Kansas City, Mo.

Enterprise Coal Co., mine No. 2 (formerly known as the Ellard mine); one and one-half miles east of Hartford; slope opening; railroad connections, Midland Valley; W. H. Miellmier, manager.

Enterprise Coal Co., mine No. 1; one and three-quarter miles east of Hartford, slope opening; railroad connections, Midland Valley; W. H. Miellmier, manager.

Enterprise Coal Co., mine No. 3. (formerly known as the Dallas mine); one mile east of Hartford, Ark.; slope opening; railroad connections, Midland Valley; W. H. Miellmier, manager.

Excelsior Smokeless Coal Co., mine No. 1; three and one-half miles east of Hackett; slope opening; railroad connections, Midland Valley and Frisco; Frank A. Graham, manager.

G. F. Petty Coal Co., Pigeon Hole mine; at Jenny Lind; railroad connections, Iron Mountain; G. F. Petty, manager.

Greenwood Coal Co., mine No. 2; slope opening; one mile east of Greenwood; railroad connections; Midland Valley; R. A. Young, superintendent; Ed Knox, foreman.

Hartford Valley Fuel Co., mine No. 2; shaft opening; 188 feet deep; one and one-half miles southeast of Hartford; railroad connections, Midland Valley; John M. Young, general manager, 311 South Olive, Pittsburg, Kansas; J. V. Anderson, foreman, Hartford, Ark.

Hackett Coal Mining Co. (Border Mine); slope opening; one and one-quarter miles west of Hackett; railroad connections, Midland Valley and Frisco; D. H. Cadmus, manager.

Hackett-Excelsior Coal Co. (Elder mine); slope opening; three and one-half miles east of Hackett; railroad connections, Midland Valley and Frisco; E. D. Bedwell, Manager, Fort Smith; operated by the Harper & Coleman Coal Co.; W. T. Harper, Foreman, Fort Smith.

Jenny Lind Smokeless Coal Co., mine No. 18; shaft opening; three miles west of station; Old Jenny Lind; railroad connections, Iron Mountain; W. K. Leyden, manager, 406 Greenwood avenue, Ft. Smith.

Jenny Lind Co-Operative Coal Co., mine No. 2; slope opening; one-half mile south of old No. 17 of the Western Coal Mining Co.; railroad connections, Iron Mountain; Chas. Herbert, manager, Bonanza, Ark.

Jim Fork Coal Co.; slope opening; three miles northeast of Hartford; railroad connections, Midland Valley; John Conroy, manager, Hartford.

Keisher Coal Co., Keisher mine; slope opening; one mile east of old No. 17; Jenny Lind; railroad connections, Iron Mountain; Frank Keisher, manager.

Katy Coal Co., Mine No. 6; shaft opening; one and one-quarter miles northeast of Midland; railroad connections, Midland Valley; H. F. Rogers, manager.

Mama Coal Co., Mine No. 5; slope opening; three-quarters of a mile southwest of old No. 17; Jenny Lind; railroad connections, Iron Mountain; Valentine Varvack, manager; Bonanza.

Mama Coal Co., Mine No. 17½; slope opening; three-quarters of mile southwest of old No. 17; Jenny Lind; railroad connections, Iron Mountain; N. M. Henson, manager.

Mama Coal Co., Mine No. 3; slope opening; one mile southwest of old No. 17; Jenny Lind; railroad connections, Iron Mountain; Jos. Dufore, manager, Bonanza.

New Excelsior Coal Co.; Italy mine; slope opening; two and one-half miles southeast of Excelsior; railroad connections, Midland Valley; G. M. Cravens, manager, Greenwood.

Smokeless Coal Co., Mine No. 2; slope opening; located one-half mile east of Montreal; railroad connections, Frisco; C. C. Woodson, president, Huntington; Chas. Woodson, foreman, Midland.

Ramsey Coal Co., Pigeon Hole Mine; one mile southeast of old No. 17; Jenny Lind; railroad connections, Iron Mountain; R. J. Ramsey, manager; R. F. D. 1, Ft. Smith.

Smokeless Coal Co., Mine No. 1; slope opening three-quarters of mile east of station; Montreal; railroad connections, Frisco; C. C. Woodson, president, Huntington; Charles Woodson, foreman, Midland.

Smokeless Coal Co., Mine No. 3; slope opening; three-quarters mile

east of station; Montreal; railroad connections, Frisco; C. C. Woodson, president, Huntington; Chas. Woodson, foreman, Midland.

Simmons Coal Co. (Wild Cat Mine); three-quarters mile east of old No. 17; Jenny Lind; railroad connections, Iron Mountain; R. C. Petty, manager, Jenny Lind.

Smith Coal Co.; slope opening; one mile west of Hackett; railroad connections, Midland Valley; Richard Smith, manager.

Security Coal Co., Dallas Mine No. 8; slope opening; three-quarters mile southwest of Midland; railroad connections, Frisco; D. H. Cadmus, manager, Hackett.

Sun Coal Co.; shaft opening; four miles east of Hackett; railroad connections, Midland Valley and Frisco; D. H. Cadmus, manager.

Turnipseed Coal Co.; slope opening; one mile east of Montreal; railroad connections, Frisco; C. C. Turnipseed, manager, Midland.

Western Coal Mining Co., Mine No. 19; slope opening; two miles northeast of Iron Mountain Station; Jenny Lind; railroad connections, Iron Mountain; A.W. Dickinson, general superintendent; Railway Exchange Bldg., St. Louis, Mo.; Milton Dollar, foreman, Jenny Lind.

Woodson-Barr Coal Co., Mine No. 135; slope opening; three miles east of Bonanza; railroad connections, Frisco; R. J. Barr, manager, 123 Greenwood avenue, Ft. Smith.

Young Coal Co., Golden Goose Mine; slope opening; one-half mile south of Jenny Lind, Ark.; railroad connections, Iron Mountain; J. W. Young, manager.

Simon Coal Co., Pigeon Hole Mine; slope opening; one-quarter mile northeast of Jenny Lind; railroad connections, Iron Mountain; Phil Simon, manager, Jenny Lind, Ark.

Henry Cox Coal Co., Pigeon Hole Mine; slope opening one-half mile southwest of Jenny Lind; railroad connections, Iron Mountain; Henry Cox, manager.

Joe Smith Coal Co., Pigeon Hole Mine; slope opening; three-quarters mile southwest of Jenny Lind; railroad connections, Iron Mountain; Joe Smith, manager.

W. Vehitting Coal Co., Strip Mine; one mile east of Jenny Lind; railroad connections, Iron Mountain; W. Vehitting, manager.

G. W. Gunn Coal Co., Strip Mine; one-half mile east of Jenny Lind; railroad connections, Iron Mountain; G. W. Gunn, manager.

Midland Coal Co., Mine No. 5; Pigeon Hole Mine; slope opening; two miles northeast of Midland; railroad connections, Midland Valley; W. D. Robinson, manager.

New Corrado Coal Co., Mine No. 1; slope opening; three-quarters mile east of Arkoal; railroad connections, Frisco; C. E. McKoin, general manager, Huntington; B. J. Malone, superintendent, Arkoal.

Rush Coal Co., Rabbit mine; pigeon hole; slope opening; two and one-half miles southeast of Hartford; railroad connections; Midland Valley; W. H. Rush, manager.

FRANKLIN COUNTY.

Alix Coal Co., Superior Mine; slope opening; one and one-half miles east of Alix; railroad connections, Iron Mountain; James A. Lewis, manager.

Douglas Coal Co., Douglas mine; shaft opening; two miles east of Alix; railroad connections, Iron Mountain; Ben Douglas, manager.

Haskell Coal Mining Co., Strip mine; three miles north of Branch; railroad connections, Arkansas Central; S. C. Awbrey, manager, Ft. Smith, Ark.

Joe Hoeing Coal Co.; slope opening; one and three-quarter miles northeast of Alix; railroad connections, Iron Mountain; Joe Hoeing, manager; Coal Hill, Ark.

The W. E. B. Coal Co., Strip Mine; two and one-half miles north of Branch; railroad connections, Missouri Pacific; S. C. Awbrey, manager, Ft. Smith, Ark.

Semi-Anthracite Coal Mining Co., Sambo mine; shaft opening one mile east of Alix; railroad connections, Iron Mountain; H. C. Parmelee, manager, Coal Hill.

Western Coal Mining Co., mine No. 2; shaft opening; one-half mile west of Denning; railroad connections, Iron Mountain; A. W. Dickinson, general

superintendent; Railway Exchange Bldg, St. Louis, Mo.; William Eadie, superintendent, Denning.

Western Coal Mining Co., Mine No. 6; shaft opening; one and one-half miles west of Denning; railroad connections, Iron Mountain; A. W. Dickinson, general superintendent, Railway Exchange Bldg., St. Louis, Mo.; William Eadie, superintendent. Denning.

Denning Coal Co., Pendergrass Mine; shaft opening; two miles west of Denning; railroad connections, Iron Mountain; G. A. Slye, manager, Denning; W. H. Lewis, foreman, Alix.

Liberty Coal Co., Liberty mine; slope opening; two and one-half miles west of Denning; railroad connections, Iron Mountain; Mat Evans and Ham Leding, operators, Altus.

Harbottle & Bailey Coal Co., Mine No. 10; slope opening; two and one-half miles west of Denning; railroad connections, Iron Mountain; Harbottle & Baley, operators, Altus.

Black Diamond Coal Co., slope opening; two and one-half miles west of Denning; railroad connections, Iron Mountain; H. Page manager, Altus.

Altus Domestic Coal Co.; slope opening; two and three-quarter miles west of Denning; railroad connections, Iron Mountain; operated by D. E. Kline, J. W. Jackman, W. G. Styles and J. B. Hale, Altus, Ark.

JOHNSON COUNTY.

Blue Hill Coal Co., Wallace McKinney mine; shaft opening; three miles east of Alix; railroad connections, Iron Mountain; H. C. Parmelee, manager, Coal Hill.

George E. Dodson Coal Co., Mine No. 1; shaft opening; one mile south of Denning yards; railroad connections, Iron Mountain; mine is being reopened by Dave Pendergrass, Altus.

George E. Dodson, Coal Co., Mine No. 2; shaft opening; one mile east of Denning yards; Sam Sampson, manager, Denning, Ark.

Clark-McWilliams Coal Co. (Igo mine); shaft opening at the McWilliams Spur; West of Spadra; railroad connections, Iron Mountain; T. M. Clark, manager, Clarksville.

Collier-Dunlap Coal Co. (Tight Wad Mine); shaft opening; one and one-half miles east of Hartman; railroad connections, Iron Mountain; H. W. Collier, manager, Clarksville.

Douglas & Son Coal Co., Blue Goose Mine; shaft opening; one and one-quarter miles southwest of Coal Hill; railroad connections, Iron Mountain; Ben Douglas, manager.

Johnson Coal Co., Blue Bird Mine; shaft opening; one mile east of Hartman, Ark.

Boston Spadra Coal Co.; Daley Mine; near Hartman; A. O. Nichols, general manager, Joplin, Mo.; E. H. Fontain, superintendent, Clarksville, Ark.

Alvin Laster, Sterling Anthracite Coal Co., mine; shaft opening; three miles south of Clarksville.

Warner Dunlap Coal Co., strip mine; three miles north of Spadra; Warner Dunlap, manager, Clarksville.

Albro Martin, Coal Co., strip mine; two and one-half miles north of Spadra; Albro Martin, manager, Clarksville.

Rosson-Rowe Coal Co., strip mine; three miles north of Spadra; Sam Rosson, manager, Clarksville.

Johnson-Cunningham; strip mine; two and one-half miles north of Spadra; railroad connections, Iron Mountain; E. H. Johnson, manager, Clarksville.

Kemp-Harding Coal Co., Kemp-Harding mine; shaft opening; near Spadra; railroad connections, Iron Mountain; J. M. Whitting, manager.

Fafter Coal Co., Fafter Mine; shaft opening; two miles east of Alix; railroad connections, Iron Mountain; H. C. Parmelee, manager, Coal Hill, Ark.

Spadra Coal Co., Sunshine mine; shaft opening; near the station. Montana; railroad connections, Iron Mountain; D. A. McKinney, manager, Clarksville.

Smokeless Anthracite Coal Mining Co.; shaft opening; two miles west of Spadra; railroad connections, Iron Mountain; J. E. James, manager, Clarksville.

Johnson-King Coal Co., Johnson-King Mine; shaft opening; three miles north of Spadra; railroad connections, Iron Mountain; E. H. Johnson, manager, Clarksville.

Lucas Mardis Coal Co., Kneed More Mine; shaft opening; near the Sunshine Mine, Spadra; railroad connections, Iron Mountain; P. P. Mardis, manager, Clarksville.

Spadra Creek Coal Co., Pig Mine; shaft opening, near the Kneed More Mine; railroad connections, Iron Mountain; E. J. Mardis, manager, Clarksville.

W. A. Hill Coal Co., Hill Mine; shaft opening 40 feet deep; two and one-half miles east of Denning yards; railroad connections, Iron Mountain; W. A. Hill, manager, Coal Hill.

LOGAN COUNTY.

C. N. Alexander Coal Co.; shaft opening; two miles south of Scranton; railroad connections; Missouri Pacific; C. N. Alexander, manager.

Davis Coal Co.; slope opening; six miles northwest of Paris; railroad connections, Missouri Pacific; W. T. Davis, manager.

Grand Coal Co.; Mine No. 1; shaft opening; three-quarters mile northeast of Paris; railroad connections; Missouri Pacific; W. A. Tinsley, manager.

Grand Coal Co.; Mine No. 2; slope opening; one mile northeast of Paris; railroad connections, Missouri Pacific; W. A. Tinsley, manager.

Hendricks Cook-Coal Co.; slope opening; Paris; railroad connections, Missouri Pacific; C. H. Hendricks, manager.

Watson-Sons Coal Co.; slope opening; one-half mile north of Paris; railroad connections, Missouri Pacific; Jos. Watson, manager.

James A. Cane Coal Co.; Independent mine; slope opening, at Paris; railroad connections, Missouri Pacific; James A. Cane, manager.

New Blue Ribbon Coal Co.; slope opening; west of Paris; railroad connections, Missouri Pacific; H. Wann, manager.

Liberty Coal Co.; slope opening; one-half mile northwest of Paris; railroad connections, Missouri Pacific; Chas. Wahl, Jr., manager, Paris, Ark.

Local Coal Co.; slope opening; Paris; railroad connections, Missouri Pacific.

New Union Coal Co.; slope opening; two miles west of Paris; railroad connections, Missouri Pacific; H. S. Forrester, manager.

Ramie Coal Co.; slope opening; one mile northeast of Paris; railroad connections, Missouri Pacific; J. R. Ramie, manager.

W. H. Coats Coal Co.; slope opening; Paris; railroad connections, Missouri Pacific; W. H. Coats, manager.

Jewel Coal Co. (old Paris Mine); shaft opening one and one-half miles north of Paris; railroad connections, Iron Mountain; Chas. A. Gaither, superintendent.

POPE COUNTY.

Southern Anthracite Coal Mining Co.; Bernice Mine No. 1; shaft opening, 486 feet deep: three and one-half miles southeast of Russellville; railroad connections, Iron Mountain and Dardenelle Branch; J. G. Puterbaugh, president, McAlester, Oklahoma; E. W. Hogan, superintendent, Russellville.

Southern Anthracite Coal Mining Co., Mine No. 2; slope opening: three miles southeast of Russellville; railroad connections, Iron Mountain and Dardenelle Branch; J. G. Puterbaugh, president. McAlester, Oklahoma; E. W. Hogan, superintendent, Russellville.

Chas. Reynolds Coal Co.; slope opening; four miles northwest of Russellville; Chas Reynolds, manager.

Ouita Anthracite Coal Mining Co.; three miles west of Russellville.

Nolen-Heir & Gilbreath Coal Co.; five miles northwest of Russellville; R. I. Noland, manager, R. F. D. 3, Russellville.

Lewis Coal Co., Ouita Mines Nos. 1-2; shaft openings; three and one-half miles northwest of Russellville; B. V. Lewis, manager, R. F. D. 3, Russellville.

SCOTT COUNTY.

Hodge Coal Co.; slope opening; Bates; railroad connections, Waldron Branch, Kansas City Southern; idle.

Bethel Coal Co.; Heavner Mine; slope opening at Bates; idle.

Harper Coal & Coke Co.; Mine No. 1; at Baley; idle.

Bates Smokeless Coal Co.; Mine No. 2; slope opening; Bates; J. G. Puterbaugh, president, McAlester, Okla.; idle.

CRAWFORD COUNTY.

John Owens, Grassy Lake Mine; near Alma; idle.

WASHINGTON COUNTY.

J. W. Turnsill; two and one-half miles south of Baldwin.

J. R. Stanberry, Baldwin; idle.

H. M. Reed, Baldwin; idle.

W. M. Edwards & Son Coal Co.; Baldwin; idle.

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Production of Coal In Arkansas By Years.

Year	Short Tons	Year	Short Tons
1840	220	1902	1,943,932
1860	200	1903	2,229,172
1880	14,778	1904	2,009,451
1881	20.000	1905	1,934,673
1882	22,000	1906	1,864,268
1883	50,000	1907	2,670,438
1884	75,000	1908	2,078,357
1885	100,000	1909	2,377,157
1886	125,000	1910	1,905,958
1887	129,600	1911	2,106,789
1888	276,871	1912	2,100,819
1889	279,584	1913	2,234,107
1890	399,888	1914	1,836,540
1891	542,379	1915	1,652,106
1892	535,558	1916	1,994,915
1893	574,763	1917	2,143,579
1894	572,626	1918	2,227,369
1895	598,322	1919	*1,285,738
1896	675,374	1920	*1,990,263
1897	856,190	1921	*1,253,552
1898	1,205,479		
1899	843,554		
1900	1,447,945		
1901	1,816,136		

*Tonnage of Southwestern Interstate Coal Operators' Association, estimated at 95 per cent of total production.

Diamonds

Four areas of peridotite (diamond-bearing rock) near Murfreesboro, Pike County, are described in a report by Hugh D. Miser, (Bulletin 540—U) published by the U. S. Geol. Surv. in 1913. One of these, that near the mouth of Prairie Creek, has been known to geologists since 1842. The rock was not known, however, to be peridotite until 1889, when Branner and Brackett studied and described the nature of the rock and its geologic relations. It is said that Dr. Branner spent half a day searching the surface of the small area for diamond specimens. Not finding any of the precious stones he refrained from making a sensational announcement or arousing undue hopes, but published his discovery in a conservative report that at the time attracted the attention of the scientists more for its importance in suggesting the time and character of the disturbing influences, which about the close of the Cretaceous sank the greater part of Arkansas beneath the ocean, than for its value in disclosing a new diamond field. Dr. Branner's extreme caution, displayed in this matter, was due, no doubt, to his consideration for the

Reduction Plant, Arkansas Diamond Corporation, Murfreesboro, Ark.

public mind which, at about that time, had been disappointed by the failure to find gold in the same region, following a tremendous excitement and the loss of many millions of dollars in unwise mining ventures.

The first diamonds were actually found in 1906, seventeen years after the visit of Doctor Branner to the Prairie Creek district. To John Huddleston, now of Arkadelphia, belongs the credit of discovering the first diamonds. These rough stones were sent to a Little Rock jeweler and were later cut by Tiffany in New York, being pronounced perfect gems, equal in purity to those of South Africa. Thus the public came to know of the presence of diamonds in Arkansas. The lands containing the deposits were purchased, the town of Kimberly was established and mining operations were begun by several companies.

According to the best information that is available at least 5,000 diamonds were found up to the end of 1919. These included, white, brown and yellow stones and a canary-colored octahedron weighing 17.85 carats and a clear, flat stone of .11 carats. Only one company has operated in the field since 1913, and that upon a small scale. However, it is said that sufficient diamonds have been found to defray the small maintenance expenses.

The Arkansas Diamond Corporation, in 1920, erected and put in operation a modern reduction plant on its property near Murfreesboro, this plant having equipment necessary to wash 100,000 tons of earth annually.

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Miser, H. D.—New Areas of diamond-bearing peridotite in Arkansas. U. S. Geol. Surv., Bulletin 540.

Dog-Tooth Spar

This variety of calcite less common than rhombohedrons. Magnet Cove.

Dolomite

Ferriferous and cobalteferous; Hot Spring, Polk, Scott, and Logan counties.

Eleolite

In coarse crystals in granite rock; also in massive rocks; distribution general and abundant in regions of metamorphic rocks. Pulaski, Saline, Garland, Hot Spring, Montgomery, Pike, and Polk counties.

Epsom Salt

In caves and old mine tunnels in North Arkansas.

Fahlunite

Hydrous silicate of Hydro-mica group. (Hydrous lime mica). From alteration of Iolite. Usually in granitic or hornblende rocks. Magnet Cove.

Florite (Opal)

In form of Pealite, etc.; products of hot springs; sand Carbonate mine, Saline County.

Fluospar

Garland County, near Lawrence; not mined.

Freibergite

Kellogg and McRae mines, Pulaski County, Silver City region, Montgomery County, Sevier County; not mined.

Fuller's Earth

The developed deposits of Fuller's earth in Arkansas occur in an area of about three square miles which lies between Hot Springs and Benton. The Missouri Pacific railroad passes through this area about seven miles west of Benton. * * * These deposits were discovered in 1897, by John Olsen of Benton. Mr. Olsen at first shipped the crude earth to the Fairbanks Packing Company, St. Louis, by which it was milled and used. He later erected at Klondyke station a plant for milling the crude earth. At present the other operators owning plants within the area are the Fuller's Earth Union (Ltd.) of London, England; the Fuller's Earth Company, General, of Wilmington, Delaware, and Fred Rossner, of Little Rock.

(A showing of Fuller's Earth is also reported in NE. ¼, S. 24, T. 8S., R. 25 W.)

Arkansas was the second largest producer of Fuller's earth in the United States from 1904 to 1907, Florida being first in amount of production. During 1909, 1910 and 1911, Arkansas was third in output and value, Florida being in first place and Georgia second. The amount of Fuller's earth produced in Arkansas in 1909 was 2,314 short tons, valued at $18,313.00; in 1910 it was 2,563 short tons, valued at $29,137.00.

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Garnet

Include here Almandite, Andradite, Aplome, Grossularite. See Schorlomite. All occur in "float," also in garnet rock (grossular) and in granitic and feldspathic rocks. Magnet Cove.

Geyserite

Silica (Opal). See Pealite, Fiorite, Girasol, Siliceous sinter. (Opal). In heavy deposits covering large areas, but of varying character. See under special names; Porcelain variety (Girasol) like Yellowstone Park deposits north of Magnet Cove, at "Spanish Diggings." Magnet Cove.

Girasol (Opal)

About ancient hot spring bowls, with tendency to cuboidal jointing.

Glass Sand

Since the establishment of glass factories at Fort Smith and Texarkana, where these industries have access to natural gas, the cheapest and best of fuels, a more convenient market is afforded for the valuable glass sands of the state. It is said that the Fort Smith plant uses 1,000 tons of sand a month and that the Arkansas sands are preferred, but because of an inability to get cars for the shorter haul the material at present is brought from Pacific, Missouri.

The glass sands of the saccharodial sandstone, (St. Peter) quarried at Guion, Izard County, are probably the purest and most extensive in the state. This sand is so pure that it is not even stained. Glass sands are found in the St. Peter sandstone in North Arkansas from Batesville to Fayetteville. It is quite as good as the best glass sands of Missouri but is of finer grain.

The King's River member of the Everton limestone formation in Carroll and Madison Counties is recommended as a glass sand.

At Whitlock Spur, near Bryant, Saline County, there is an extensive deposit of high grade glass sand.

Purdue says: "The novaculite of the Ouachita Mountains probably would produce glass of fine quality."

A deposit of glass sand is reported in Jefferson County near Pine Bluff.

With reference to the glass sands of Crowley's Ridge, in Greene County, the following is quoted from the report of the Arkansas Geological Survey, Vol. II, 1889.

"The sand is white. * * * It would make an excellent bottle glass sand, or even the cheaper grades of window glass could be made from it. Its product would be green in color, but less deep than the common green bottle glass, owing to the small amount of iron present. With soda and lime added it would make a fairly good window glass."

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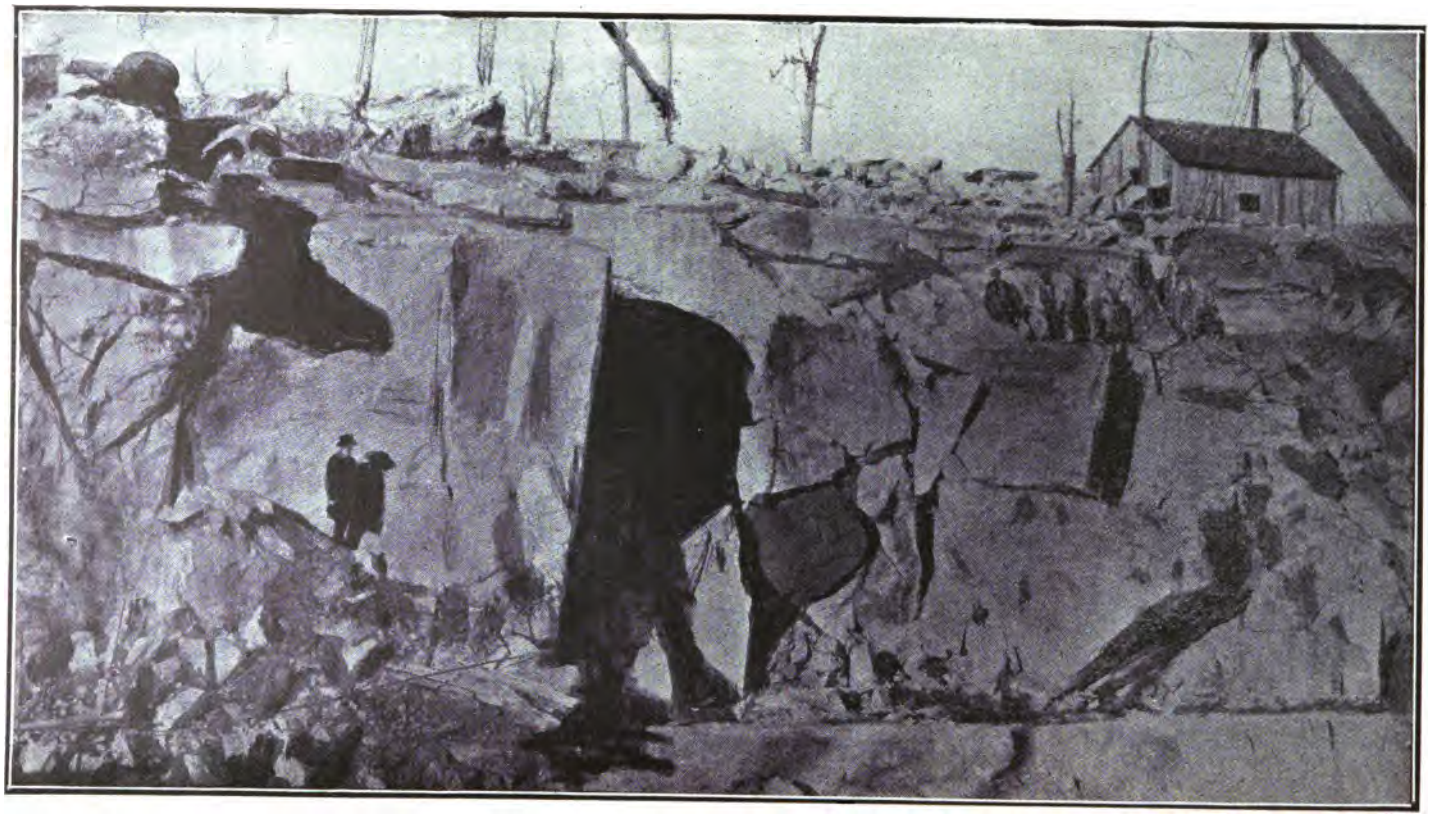

Blue Granite (Pulaskite) Quarry Near Little Rock

Gold

For many years there has been a vague, but persistent faith in the existence of gold in paying quantities in Arkansas. From time to time repeated discoveries of this metal have caused much excitement in different localities. One by one the successive "finds" have proven barren when thoroughly tested. The little known portions of the mountainous country have always been regarded curiously and reported discovery in those regions have received more ready credence, perhaps because of the supposed existence of granite rocks.

The various agencies which have been at work in Arkansas have not had access to any important supply of gold; the processes of deposition have acted too rapidly to accumulate gold in workable deposits; the auriferous deposition, if any has taken place, has been spread over such vast areas as to dilute the whole to a condition of extreme poverty; there has been no special accumulations; structural conditions are unfavorable; gold is absent in situations most favorable for its retention and is invariably absent in the "float" and the sands and gravels. Nowhere has gold been found in workable quantities.

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"Granite" (Syenite)

The total area of igneous rock exposed within the boundaries of the State of Arkansas does not exceed thirteen or fourteen square miles, but the value of these rocks as building and paving materials gives them great economic importance.

The eleolite syenites were probably all produced from one magma, but since they occur in four well-defined areas, and as the rocks which form these various areas differ greatly in their mineralogic independent groups, which can hardly be sufficiently correlated with the others to allow of their all being described together.

These four regions are:

1. The Fourche Mountain or Pulaski County region.
2. The Saline County region.
3. The Magnet Cove region.
4. The Potash Sulphur Springs region.

Outside of these four typical regions there are many dikes of igneous rock which as far as their petrographic characteristics are concerned might be associated, as well with one group as with another, and which are, as a matter of fact, probably directly connected with none of them, although formed from the same magma from which they all derived their material.

(In additon to the masses described there are four masses of peridotite near Murfreesboro, Pike County, together with a number of related dikes. A study of these masses has proved that these igneous rocks of Arkansas were all probably formed during the land interval separating the upper and lower Cretaceous periods.)

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Washington, H. S.—The igneous complex of Magnet Cove, Arkansas. Abstract, Science, March 16, 1900, Vol. XI, Bulletin Geological Society of America, Vol. XI, Rochester, 1900. Review, American Naturalist, Vol. XXXV, May 1901. Review, Technology Quarterly, Vol. VII.

Graphite

Graphite is abundant and pure in many localities in the Trap Mountains in Hot Spring County. It occurs also in the form of graphitic shale in Garland and Montgomery counties. Some of this material is of excellent quality, while some of it occurs in streaks or pockets only, and much is mixed with earthy matter. The impure varieties are available for paints.

Purdue says: "Possibly the most promising outcrop is in the bed of Collier Creek at Buttermilk Springs, northeast of Caddo Gap in Montgomery County.

Drake reports the presence of graphitic Shale at the Dickinson brick yard in the southern part of Little Rock—a gray-black material suitable for paint making.

Gravel

Several thick deposits of gravel are widely distributed along the north edge of the Gulf Costal Plain. The gravels are of Lower Cretaceous, Upper Cretaceous and Quarternary age and are composed mainly of pebbles of novaculite (a variety of chert) derived from the Arkansas novaculite exposed in the Ouachita Mountain region. They are used in making concrete, in ballasting railroads and in the construction of wagon roads. The Pike gravel is the thickest and most persistent gravel bed in the area and has a larger surface distribution than any other. The thickness is rather uniform, being in most places between 20 and 50 feet, but it apparently attains 100 feet near Pike. This gravel consists of pebbles usually less than half an inch in diameter, but it contains many larger ones and also many cobbles as much as ten inches in diameter. These pebbles have not been used in tube mills, but they are of such a character that it is believed well selected pebbles may be suited for this purpose.

The gravel beds of Crowley's Ridge in Northeast Arkansas are of varying thickness, being deposited on a surface which indicates very considerable erosion at a period prior to their deposition. The gravels are made up mainly of a light-colored chert, are generally well rounded or waterworn, rarely angular and always well polished. When in place they are always rudely assorted, cross-bedded and mingled with more or less sand. The gravel is considerably above the general level of the country, reaching often to the very tops of the highest hills. Deposits occur at various points along the ridge from the Missouri border to Helena.

In the bed of the Arkansas River throughout its course in Arkansas and in the beds of many of its tributaries, are gravel bars containing large quantities of material suitable for road-building.

On the higher hills about Little Rock and northwest of that city are quantities of surface gravel. Similar ridges occur in Saline, Grant and Dallas counties and in other parts of Southwest Arkansas.

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Greenockite

In zinc and lead districts of North Arkansas.

Grossularite

See Garnet. Grossular rock and other non-crystalline or crypto-crystalline forms. Magnet Cove.

Gypsum

"The Trinity formation (of Southwest Arkansas) is rich in gypsum and gypsiferous marls, the latter too impure for the arts, but suitable for an agricultural fertilizer or land plaster. At the gypsum bluff, or "Plaster Bluff," as it is familiarly called, two and one-half miles south of Murfreesboro, in Pike County, there are strata of pure saccharoidal alabaster, from 6 inches to 6 feet in thickness, with seams of satin spar. This gypsum is sufficiently pure to make plaster of paris, as well as fertilizer, and will no doubt be a source of much wealth to the country some day. The same geologic horizon as that containing the gypsum beds on Little Missouri River outcrops sparingly at many points along the southern scarp of the Fort Towson road valley."—Report Arkansas Geol. Surv., Vol. II, 1888.

Prof. A. H. Purdue mentions the presence of gypsum on Messers Creek, north of Center Point, in Howard County.

Gypsum, or "satin spar," occurs in broad crystals, fibrous and earthy, in the zinc and lead districts of North Arkansas. This mineral also has been observed in parts of Saline County where pyrite and limestone are found.

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Halotrichite

Incrustations in black shale; Sloan's well, Black Spring, Montgomery County; Cox's Alum Springs near Boles, Scott County.

Hornblende

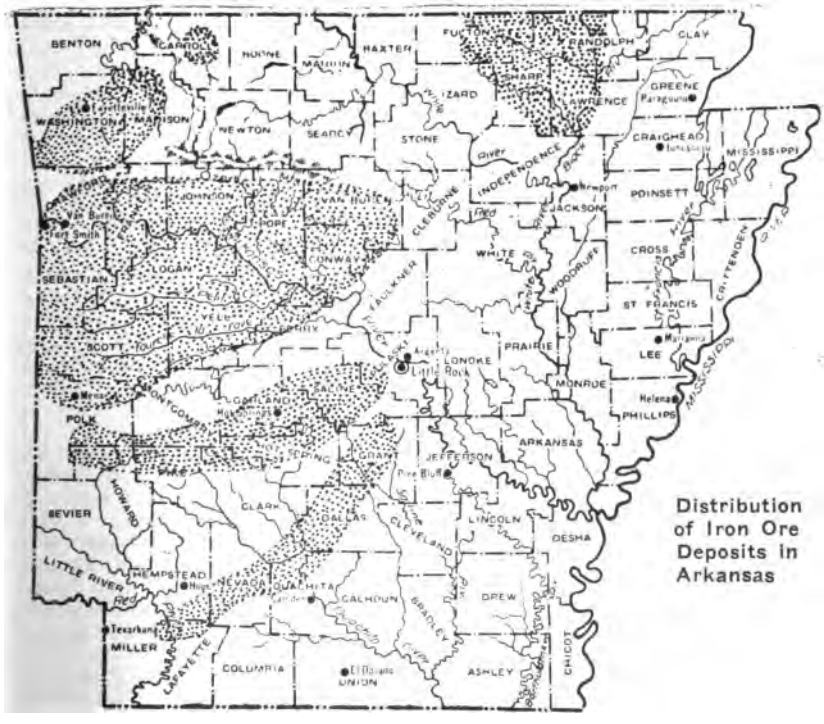
Aluminous magnesia-lime Amphibole. In syenites; Diamond Jo quarry and other places near and in Magnet Cove.

Hydrotitanite

Altered Perofskite. In crystals, locally, form perofskite, but gray color. Magnet Cove.

Hypersthene

Magnesia-iron-silicate. Some of the labradorite rock, bearing brookite crystals, has also this mineral. Magnet Cove.



Distribution of Iron Ore Deposits in Arkansas

Idocrase

Aluminum-calcium-iron-magnesia silicate. Vesuvianite (Syn.); as idocrase rock, sometmes with imbedded crystals. Magnet Cove.

Iolite

Alumina silicate, with other bases. In metamorphic rocks, rarely in unaltered condition. See Fahlunite for altered forms. Magnet Cove.

Iron

The result of the survey's investigation of the iron deposits of the state have not met the expectations and hopes of their commercial value, with which the work was begun. The number of places at which iron deposits occur throughout the state is almost endless, but the examination of these deposits and the chemical analyses of the ores show that most of them are either too limited in extent, or that they are too low in grade to admit of their being worked. The deposits of Lawrence and Sharp counties are the only ones that merit attention, and whether these deposits can be worked now must depend on economic conditions—transportation, markets and competition.

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Iron Pyrites

The constantly increasing use of pyrites in the manufacture of sulphuric acid may make available in the future the deposits which occur on the South slope of West Mountain, two miles west of Hot Springs, Garland County; in Southern Polk County and at Golden City, in Logan County.

Pyrite ("fool's gold," "mundic," iron disulphide; sulphur, 53.4; iron, 46.6 per cent; brass yellow, often in cubes, sometimes massive), found in small quantities at a few of the zinc mines in North Arkansas; notably hard.

Jasper

Of various colors, among the ancient hot spring deposits; Montgomery County; Caddo Gap, Polk County; Eagle Hill.

Jefferisite

Micaceous, swells enormously when highly heated; associated with aegerite-rock, and among other metamorphic rocks, as serpentine; north of Magnet Cove; Garland and Hot Spring counties; south of Hot Springs; McAllister's mill, Saline County; Montgomery County.

Labradorite

Lime-soda feldspar; as base of intrusive rocks, in basaltic and other basic rocks.

Lead

"Galena (lead sulphide)—the principal lead ore mineral—has been mined in limited quantities in Baxter, Benton, Carroll, Boone, Marion, Newton, Washington, and other counties of Northern Arkansas. In Western Arkansas it has been found sparingly and mined occasionally in Garland County, near Blakely Creek; Hot Spring County, at Point Cedar; Montgomery county, at Rubicon, near Virginia City and at Minnesota, Montezuma, Walnut and Waterloo mines; Pulaski County, Kellogg and McRae mines; Sevier County, at Bellah mine, in Gulch shaft, New Discovery shaft, near Conboy and elsewhere. Cerusite (lead carbonate) occurs in Howard, Montgomery, Newton and other counties, with galena and coating it in mines in Northern Arkansas."—Bulletin 624, U. S. Geol. Surv., Useful Minerals of the United States.

MINE PRODUCTION OF LEAD IN ARKANSAS

Year	Short Tons	Year	Short Tons
1909	19	1915	437
1910	28	1916	820
1911	24	1917	852
1912	....	1918	564
1913	18	1919	687
1914	28		

The ores are galena, sphalerite and smithsonite and the concentrates produced are generally of high grade and free from or very low in iron or lime. The sphalerite has frequently assayed 2 to 3 per cent above the price basis of 60 per cent, metallic zinc content. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite, known locally as turkey fat, which shows as high as 0.8 per cent of cadmium.

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Lignite

Extending northwestward from Camden, is a small area of typical brown subcannel coal, which has been tested for oil and gas production with very favorable results. The coal bed has been traced from about 2 miles northwest of Camden for 13 miles to the northwest and has been opened and mined in a small way at a number of places. The coal ranges from 3 to 6 feet in thickness.

Physically the Camden coal, as it comes from the mine is brownish black and compact and has a generally uniform even texture and structure. Occasionally fragments of lignite with clearly marked woody structure may be seen. It has an uneven conchoidal fracture. It is soft but not friable, that is, it may be easily mined with the pick and may be cut with a knife as readily as compact dry clay, but will not crumble between the fingers. When cut or scratched with a knife it shows a shiny or oily streak. Upon being exposed to dry air, the coal contracts and cracks both along the bedding and at right angles to it so that fragments may be broken by the hand, but the mass does not fall to pieces. The coal is then blacker and harder than when fresh and the streak or powder is more nearly black. On being exposed for a short time to the repeated action of rain, dew, and snow, however, it will disintegrate into small particles.

From this description the coal is evidently of lignite rank, but so far as tested it appears to give a higher candlepower gas than other lignites. Chemically, as shown by the analyses it contains from 32 to 38 per cent of water when fresh. In dry air the moisture will reduce to 9 to 11 per cent, but this will be reincreased to 20 to 22½ per cent if the coal is submitted to saturated air. The volatile matter in the fresh coal is 32 to 36 per cent and 44 to 46 per cent in the air-dried coal; and the fixed carbon in the fresh coal is 17 to 23 per cent in the air-dried coal. The ash remains from 7.5 to 11 per cent in the fresh coal and sulphur 0.5 per cent or less in the fresh material.

This coal was tested by the Pittsburgh Testing Laboratory. The average result of 10 tests, at a temperature of 1,800 to 2,000 degrees F., was a yield of 11,386 cubic feet of 22.3 candlepower gas.

Tertiary lignites occur in most of the counties of Southern Arkansas. Probably the deposits nearest approaching in value those of the Camden district are in Pike and Clark counties, but no use has yet been made of this fuel. The location of the lignite is more interesting as indicating the character of the associated clays.

LIGNITE OF CROWLEY'S RIDGE

The lignites of the Crowley's Ridge region are all of Tertiary age. * * * They occur in the form of outcrops along the streams and in gullies with an

occasional bed appearing in wells. The thickness of these lignite beds is exceedingly variable. Usually they are less than five feet thick, though the Bolivar Creek beds in Poinsett County are seven feet or more in thickness. It is also noticeable that the vertical distribution of the several beds is irregular, some of them occurring high up in the hills, while others are at their base or below it. So far as traced all these beds are independent of each other, having been formed at different times, and they are generally in lenticular shapes, most of which cover but a few acres and many of them but a few hundred square yards. Their chemical analyses show that the Bolivar Creek and the Clay County lignites are the best. The poorest is that found in St. Francis County, T. 4 N. R. 4 E., on Section 26.

REFERENCES

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Taff, J. A.—The Camden coal fields of Southwestern Arkansas, XXI Annual Report. U. S. Geol. Surv., Part II, pp. 313-329, 1900.

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Lithographic Stone

A somewhat extended search has been made in Arkansas for a lithographic stone, but thus far the search has been unsuccessful. The nearest approach to success was at the Warden property on West Lafferty Creek in Izard County, where a quarry was opened and considerable work done some years ago. It is reported that some good samples were obtained, which answered all the required tests, but the work suddenly ceased, as it was found that the greater part of the stone was worthless for lithographic purposes on account of the fine crystalline particles scattered through it. The crystalline parts are in some places but single crystals, in others they are fine, hair-like veins, so small as to be almost invisible to the naked eye. These crystals splinter or break with ragged edges under the engraver's tool, thus injuring the stone for fine work.

The layers from which this stone was obtained are from two to four inches thick with a total thickness of about two feet. They are overlaid by 20 feet of Izard limestone and underlaid by over 170 feet of the same rock.

The Izard limestone is a smooth, fine-grained, compact, homogeneous, non-fosseliferous, evenly bedded limestone, breaking with a conchoidal fracture and is mostly of a dark blue color, varying locally to buff, light and dark gray, and almost black. It has a specific gravity of 2.7272 corresponding to a weight of 170.45 pounds per cubic foot. A partial chemical analyses shows the following:

Insoluable in hydrochloric acid	.34
Carbonate of lime (Ca CO3)	98.67
Carbonate of Magnesia (Mg CO3)	2.14
Total	101.15

REFERENCES

Branner, John C.—Annual Report Ark. Geol Surv., 1890, Vol. IV.

Limestone

In spite of the abundance of limestone in Arkansas suitable for lime burning, the state imports lime instead of exporting it. As the limestone region of North Arkansas becomes traversed by railways the burning of lime should become one of the most important industries. There are limestones in the Tertiary and Cretaceous areas of the central and southwestern portions of the state, yet the Paleozoic limestones of the northern part of the state are so superior for lime burning that it is to them the state must look for its lime supply. The chalk beds will, no doubt, become valuable in the manufacture of Portland cement, but for common lime it cannot compete with the Paleozoic limestones.

While in North Arkansas there are not less than seven distinct beds of limestone persistent over large areas, and others of more limited extent, it is noteworthy that nearly all the lime that has been burnt has come from a

single bed—the limestone in the Boone Chert. It has a greater areal extent than any of the other beds, yet others of large extent would make equally as good lime.

Following is the analysis of limestone from the Boone chert formation in Independence County:

	Per. Cent.
Carbonate of Lime	98.43
Carbonate of Magnesia	.95
Insoluble Residue	.28

Without taking into account the proximity to transportation, the different beds of limestone considered solely in the light of their value for making lime, would rank about as follows:

First, Izard limestone.
Second, Boone chert limestone.
Third, St. Joe marble.
Fourth, St. Clair marble.
Fifth, Archimedes limestone.
Sixth, Pentremital limestone.
Seventh, Magnesian limestone.

It will thus be seen that while limestone is widely distributed in the state, all that is suitable for building purposes occurs north of the Boston Mountains, and all the rocks of any considerable importance for lime-burning occur in the same place. The chalk beds of Southwestern Arkansas are the only lime deposits south of the Boston Mountains which are likely to have any great commercial value.

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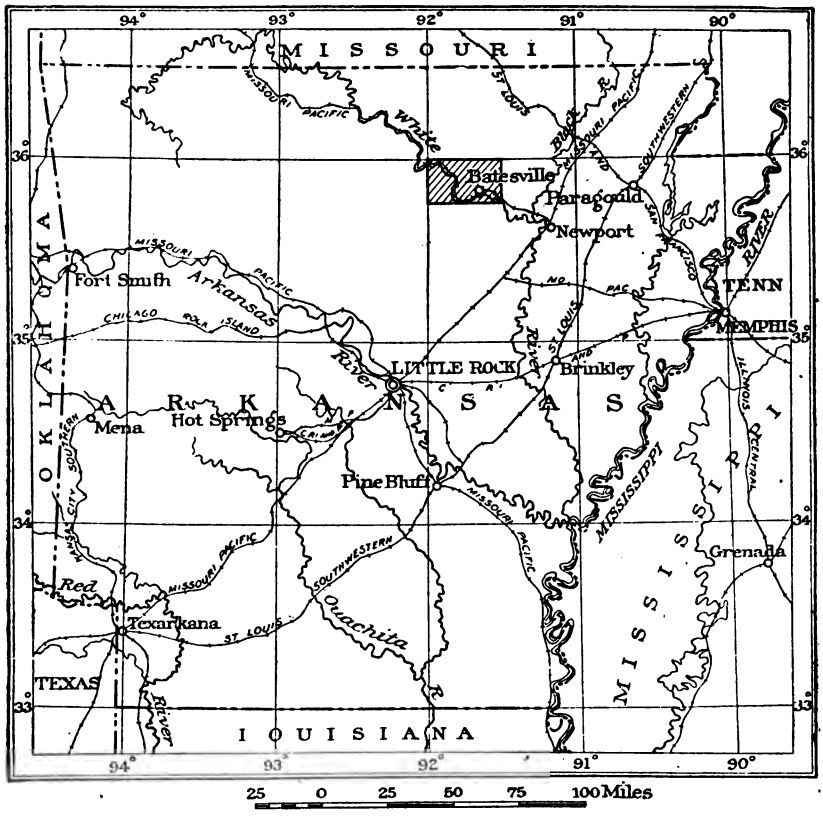
Harris, Gilbert D., Assistant Geologist.—Annual Report Arkansas Geol. Surv. for 1892, Vol. II.

Manganese Mining in Independence County.

Manganese

Manganese ores occur in two different parts of Arkansas, one in the Batesville region, mostly in Independence and Izard counties, in the northeastern part of the state; the other in the southwestern part of the state,



Map Showing Batesville Manganese Area, from U. S. Geological Survey Report.

in the region extending from Pulaski County on the east to Polk County and the Oklahoma border on the west. In the former region considerable mining has been done; in the latter the amount of work has been limited. The two regions approach, in their nearest parts, within about 90 miles of each other, the southern extension of the Batesville region being about that distance northeast of the manganese area of Pulaski County, while it is over 150 miles northeast of the manganese area of Polk County.

The developed manganese deposits in the Batesville region lie in a belt 20 miles long by 4 to 8 miles wide, which extends westward through Independence, Sharp, and Izard counties, in the northeastern part of the state, but are mainly in Independence county. Maganese is not likely to be found in every part of this belt, but the deposits, which differ greatly in size, are extensive. One hundred and eighty mines and prospects, have produced ore.

The ores are manganese oxides, chiefly psilomelane, hausmannite, and braunite. Wad and manganite also occur in minable quantity and the ores in places include pyrolusite. Although these minerals may be found separately, two or more are generally mixed in the same deposit and at a few places they are associated with ferruginous manganese ores and with small quantities of brown and red iron oxides. At some places the ferruginous manganese ores predominate.

The high-grade manganese ores generally contain 45 to 52 per cent of manganese though some of the ore shipped contains as much as 60 per cent of manganese. Most of the ores contain from 3 to 8 per cent of iron, 0.15 to 0.30 per cent of phosphorus, and 2 to 8 per cent of silicia. Some of the ore shipped contains more than 0.30 per cent of phosphorus and a very little contains 0.40 to 0.50 per cent of phosphorus. Most of the ferruginous manganese ores contain 20 to 40 per cent of manganese, 8 to 20 per cent of iron, and 5 to 26 per cent of silica. The phosphorus content is about the same as that of the higher grade ores.

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Magnetite

Magnetic iron ore. In crystalline metamorphic rocks; in a local deposit at surface and in soil in fragments; magnetic; abundant. Magnet Cove.

Malachite

Garland County, at Hot Springs, in ledge of rock several feet in thickness; not mined.

Marbles

The marble region of Arkansas is in the north and northwest part of the state. It includes Marion, Boone, Benton, and parts of Independence, Izard, Stone, Baxter, Searcy, Newton, Madison and Washington counties, and extends north into the State of Missouri. The entire region is north of the Boston Mountains, and with the exception of portions of Washington and Benton counties is in the upper White River Valley. It is commonly known as North Arkansas, the Boston Mountains forming a natural barrier between it and the remainder of the state on the south, while the flood-plains of the Black River bound it on the east.

The marbles of Arkansas all belong to the list of colored marbles; although some of them are very light colored, all are more or less stained with metallic oxides or with carbonaceous matter. On a stratigraphic basis all the numerous varieties of marbles in Arkansas are, with very few exceptions, included in three classes: The St. Clair; the St. Joe; and the gray marble of the Boone chert formation. The first of these, the St. Clair marble, occurs over the eastern and south central part of the area, and is of Silurian age. The St. Joe and gray marbles, occurring over the entire area, are at the base of the Lower Carboniferous rocks. The few varieties which do not occur in any of these classes are the black, yellow, "onyx," and Archimedes marbles.

Marble of red, gray and pink colors outcrop at numerous places along White River and its tributaries. Black marble occurs near Marshall, Searcy County, and Jamestown, Independence County.

Comparatively little work has been done to develop the marbles and bring them into the market. Probably the first piece of marble shipped out of the state was the one sent to Washington Monument in 1836, the year in which the state was admitted to the Union. The block, weighing 9.000 pounds, was taken from near Marble City, Newton County, then known as Beller's Mill. It was obtained by Mr. Beller and Elijah, Samuel and William Harp. By drilling and wedging they separated the block from a ledge four feet thick. It was then put on a log wagon and with ten yoke of cattle these four men took the stone a distance of 60 miles or more over exceedingly rough and tortuous roads across the Boston Mountains to the Arkansas River near Clarksville, whence it was shipped by boat.

Marble Quarry, Near Batesville, Ark.

The exterior walls of the new State Capitol at Little Rock were constructed of Batesville marble, quarried at Pfeiffer.

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Hopkins, T. C.—Topographic features of Arkansas marble. Proceedings of the American Association for the Advancement of Science. Vol. XXXIX, Salem, 1891.

Anonymous.—Batesville oolitic marble. Stone, Vol. XXIX, pp. 345-346. Illustrated, New York, January, 1909.

Melanite

Lime-iron Garnet, black variety of Andradite; or Aplome; loose crystals and in rock. Magnet Cove.

Melanterite

In incrustations, etc., rarely pure; Rabbit Foot mine, Saline County.

Mellite

(Honey Stone).—As incrustations on sandstones or coal measures; Scott and Franklin counties.

Mica

Biotite.—Garland County, at Potash Sulphur Springs and Magnet Cove.

Microcline

Alkaline alumina silicate; triclinic potash-feldspar. Greenish, in granitic rocks, with aegirites; othoclase or albite, sometimes associated with it. Magnet Cove

Newtonite

Pure white, soft, compact, inflexible, specific gravity, 2.37, Newton County.

Nitre

(Saltpeter). In dry caverns in limestone regions of North Arkansas.

Novaculite (Whetstones)

The Arkansas stone is a true novaculite, satisfying all the necessary condition regarding homogeneity, grittiness, finely granular structure and siliceous composition; it is translucent on the edges and has a marked conchoidal fracture. It occurs associated with shales into which it grades through opaque, flinty layers. It is the only true novaculite quarried in quantity in this country.

Novaculite is very like chert, both in composition and in its behavior as a road-making material. It occurs only in the hilly region lying south of the Coal Measures, where it forms the Zigzag Mountains about Hot Springs and the great Ouachita Mountain system south of the Ouachita River, extending from Rockport, Hot Spring County, nearly to Oklahoma, west of Dallas, Polk County.

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Novaculite in Railroad Cut, Near Glenwood.

Ochre

Ochre of a deep red color occurs abundantly near Wittsburg on Crowley's Ridge. An analysis suggests no valuable use to which this clay could be put. It is used locally for painting barns.

Deposits of yellow ochre occur near Monticello, Drew County, and Piggott, Clay County.

Brown ochre, or limonite, occurs in many parts of the state, but it is usually contaminated with clays. * * * Red ochre, Fourche Mountain and suburbs of Little Rock, usually impure from admixture with silica and clay.

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Octahedrite

Titanic oxide. Close to Rutile. See also Brookite. Occurs sparingly with Brookite, Rutile and Arkansite, also as imbedded crystals in feldspathic or garnet base Magnet Cove.

Oil Shales.

"Petroleum occurs in small quantities in the Fayetteville shale of Washington County. Everything in the general geology of this section points to the fact that the sandstone in which this oil occurs is cut off along the north face of the Boston Mountains and that the rocks through the central and northern parts of the county all lie below it. The rock does not contain enough oil to thoroughly saturate it."—Annual Report of the Arkansas Geological Survey, Vol. IV, 1888.

"Oil may perhaps be distilled from the Chattanooga shale (of northwest Arkansas) which is sufficiently bituminous to give off the odor of petroleum when struck with a hammer, but such distillation will be profitable only after the prices of petroleum and its products become higher."—A. H. Purdue and H. D. Miser.—Eureka Springs-Harrison Folio, No. 202, U. S. Geol. Surv. Among the shale rocks of Northwestern Arkansas, H. D. Miser of the U. S. Geol. Survey, includes the Bloyd shale.

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Oligoclase

Triclinic soda-lime feldspar. With orthoclase in metamorphic (granitic) rocks. Not very abundant, apparently; in syenite, more or less. Magnet Cove.

Onyx

Argonite or Mexican onyx occurs in large quantities in some of the zinc mines of North Arkansas. Doctor Branner says: "We have seen beautiful pieces of this rock that would have brought high prices in the market wantonly destroyed, partly because the owners were not aware of its value, and partly because this is a zinc mine—not a stone quarry."

From the report of T. C. Hopkins on the Marbles of Arkansas, the following facts are taken:

"None of the onyx marbles of Arkansas are quite as translucent or as brightly banded as the finest qualities of Mexican stone, yet much of it is very handsome, works easily, takes a brilliant polish and will no doubt command a good price. Further research may show even finer qualities."

Slabs containing several square feet of "Eureka onyx" have been recovered from caves near Eureka Springs and made into paperweights, clocks, scarfpins, penholders, etc. Large quantities of stone are exposed in a cave near Dodd City. It occurs in white, cream, red and yellowish brown colors. Apparently slabs four or five feet square or even larger could readily be obtained. It is a beautiful stone.

REFERENCES

Report Arkansas Geological Survey, Vol. IV, 1890.

Opal

Silicia. In certain ancient hot spring deposits. Magnet Cove.

Orthoclase

Potash feldspar. Pulaski, Saline and Hot Spring counties, in granitic and allied rocks.

Ozarkite

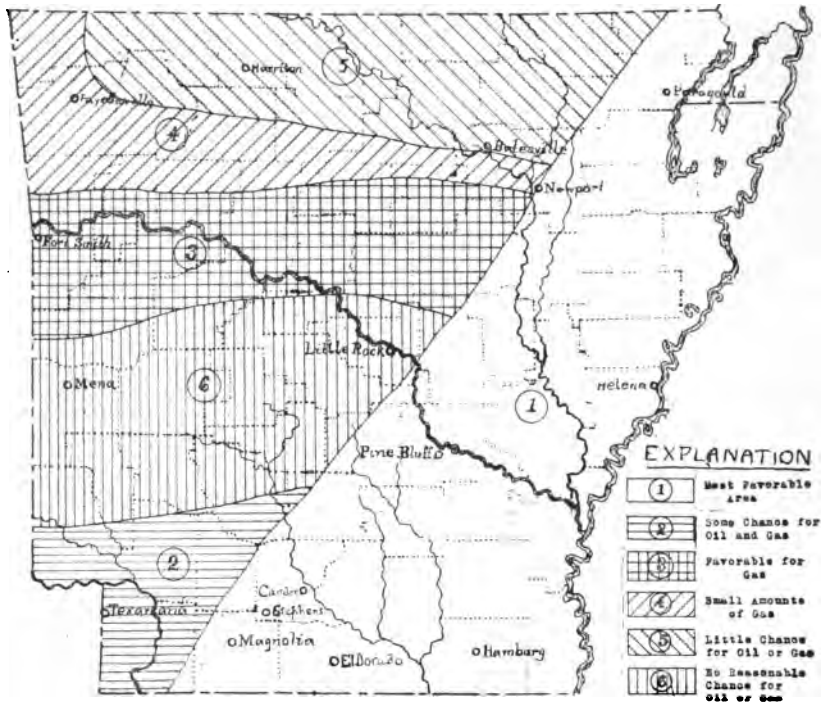
Hydrous aluminum silicate, with calcium and sodium; massive variety of Thomsonite. In masses like beds or intrusions of uncertain relations. Magnet Cove.

Paint Minerals

There are some seams or pockets of a very good quality of barytes in many places in Montgomery County, between the Broken Rock and Blue Mountain axes, and generally speaking along the whole length of that belt. Some of the barytes is white and of high value. Ground shale and impure graphite which abound in Southwestern Arkansas, especially in Montgomery County, are useful materials as fillers for paints. Red ochre (hematite) and "reddle," or a kind of red chalks, are abundant in many localities in Southwestern Arkansas. Use might be made of these in paint manufacture. The yellow and brown ochreous earths (limonite) may in some cases be useful for similar purposes. The quantity of such ore, particularly in Pulaski County, south and west of Little Rock, is enormous and easily mined.

Pealite

Silicia; variety of Opal, or Fiorite. In crumbling masses, usually with hard nuclei; constituent of old hot spring throats; sand carbonate mine. Magnet Cove.



Map of Arkansas, Illustrating Relative Chances for Oil and Gas—Drawn by Dr. N. F. Drake, Geologist for the State Bureau of Mines, and Former State Geologist.

Petroleum and Natural Gas

By N. F. DRAKE, Former State Geologist of Arkansas.

The accompanying map presents a rough outline showing different areas into which the State may be divided with reference to different degrees of fitness for petroleum and natural gas. There is more or less variation within each of these areas and usually each area, in its geological fortunes, graduates into the adjoining areas but as a whole each area as mapped forms a distinct group.

Area VI.—The area marked "6" and by vertical lining includes the Ouachita Mountain system in which the rock beds are severely folded into numerous anticlinal and synclinial folds extending almost east and west the whole forming an upward bent fold on an anticlinorium. The tops of these folds have been eroded so that now the numerous parallel ridges stand at almost the same elevation. This means that the center of the anticlinorium has been eroded more than at the sides so that now we have exposed at the surface along the central portion of the area the oldest rock beds. Going either northwards or southwards from the central oldest rocks one passes over successively younger rocks as he approaches the border of this area, except that in places severe folding has caused the complete overturning of some of the beds. In age the rocks of this area extend from the Cambrian at the base, through the Ordovician, Silurian,

Devonian and into the Carboniferous at the top. The whole gives a thickness of 15,000 to 20,000 feet of shales, sandstones, and some cherts and limestones. The whole area is rather highly metamorphosed so that a large part of the shales are graphitic and often the sandstones have been changed to quartzites. Much of the original pore spaces in these rocks have been filled by silica and lime carbonate. Igneous rocks in small areas, outcrop at a number of places. The severe metamorphism of the rocks in this area at once condemns it as a field for oil and gas.

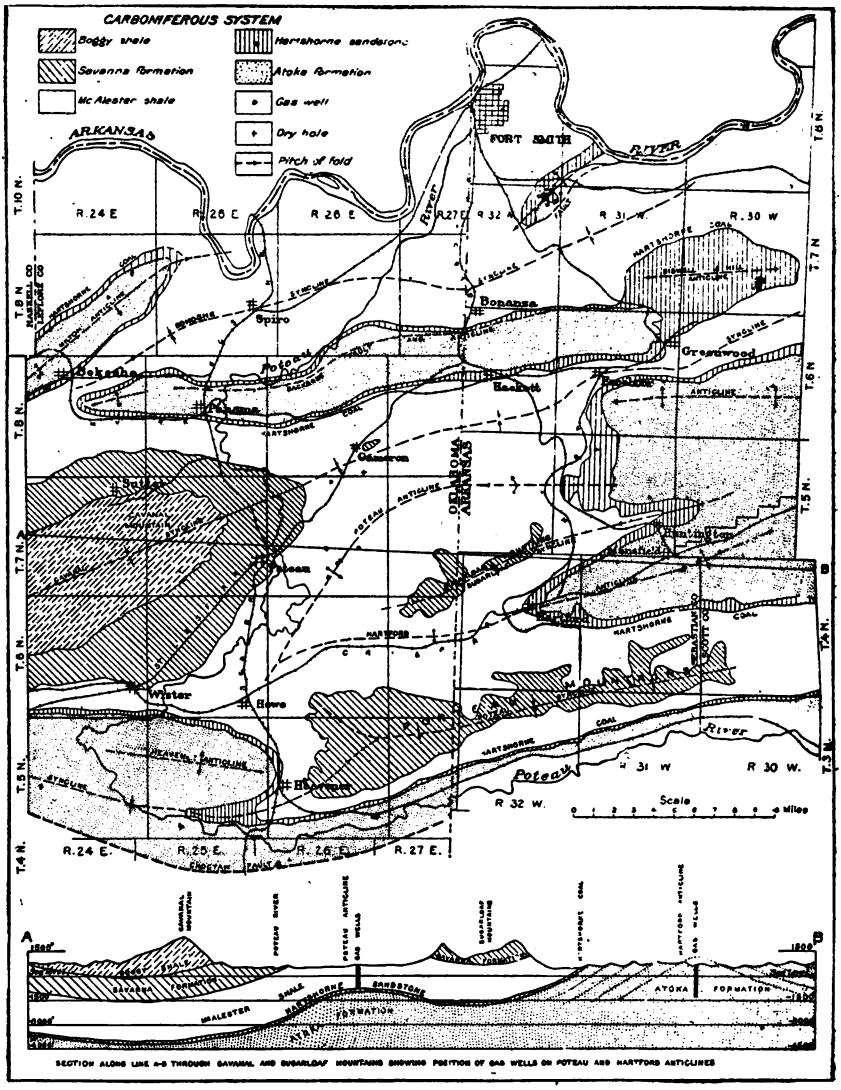
Area V.—The area marked "5" in the north central part of the state is a part of the Ozark Plateau and its exposed rock beds are mainly Ordovician dolomites and sandstones, but overlying these beds in regular order are Silurian, Devonian and Mississippian beds, the total giving somethng like 2,000 feet of outcropping rock beds within this area. Limestones, sandstone and some carbonaceous shale are found in the upper part of these beds. The rock beds are broken or faulted at many places and show some gentle folds but in the main the beds lie almost horizontal or dip slightly to the south. While metamorphic action in this area has not been severe, it has been considerable so that many of the limestones are more or less crystaline. In quarrying rocks over the area a little petroleum has been found in small cavities in some of the limestones and dolomites at a number of places. This has led some people to suspect that oil in commercial quantities might be found there. It seems very doubtful whether there is present, at sufficient depth, rock beds capable of giving origin to oil. The Chattanooga shale along the south and southwest border of the area is too near the surface for any oil it might have produced to have been retained in the rocks. The deep seated beds are mainly dolomites and sandstones. Metamorphic action here has almost assuredly been great enough to have destroyed oil accumulations even had they at one time existed. Furthermore test wells in this area and in the same rock beds nearby in Missouri have failed to give encouragement for oil and gas.

Area IV.—The area marked "4" on the map includes the south and southwest border of the Ozark Plateau. Here the rock beds lie almost horizontal, but in general, have a dip of one to two degrees to the south and southwest. At places this dip increases to five or six degrees or even more. Some gentle folding and faulting occurs over the area and heavy faulting with the downthrow on the south side of the fault planes, occurs along the south border of the area. As one goes northward over this area he reaches successively lower and older rock beds. Along the north border of the area the outcropping rocks are mainly Mississippian while on the south border they are Pennsylvanian. Wells drilled 300 to 500 feet deep near the north border, or 500 to 2,000 feet deep near the south border, would pass into the Silurian or Ordovician limestones, dolomites and sandstones. Over those beds lies the Chattanooga shale, which is usually 25 to 40 feet thick. It is highly carbonaceous and is oil and gas-producing. About 350 feet of chert with some limestone overlies the Chattanooga shale. The chert in turn is overlain by 200 to 400 feet of highly carbonaceous shale, the Fayetteville shale, that is also oil and gas-producing. Oil and gas within this area would naturally be expected to have been derived from those shale beds.

We have then in this area beds of rock favorable for the production of oil and gas, porous sandstones suitable for reservoir rock and some gentle folding giving inverted basins that might trap the oil and gas in their upward migrations. In the Northern portion of the area the covering over the oil-gas producing shales is not sufficient to prevent leakage, but in the southern portion the covering should be ample.

A well a little over 300 feet deep about five miles northwest of Fayetteville, has, for about three years, furnished enough gas fuel for cooking and heating at a farm house. This gas was struck in sandstone immediately underlying the Chattanooga shale. Without any reasonable doubt this gas came from the shale. The covering over the shale is nearly 300 feet of Boone chert which would allow gas to escape to the surface and be lost while the shale itself is nearly impervious and gas collecting under the shale would be retained.

A number of other wells widely distributed over this area have given small flows of natural gas, but commercial flows have not yet been obtained. It is rather difficult to estimate the degree of alteration or metamorphism that exists over the area. The following coal analysis by G. O.



MAP OF FORT SMITH-POTEAU GAS FIELD, ARKANSAS AND OKLAHOMA.

Burr, of the University of Arkansas, from a sample of coal taken from the Baldwin mine, situated about seven miles east of Fayetteville, probably gives a fair average for the condition of the area as a whole:

Moisture	0.87%
Volatile Combustible Matter	30.75%
Fixed Carbon	60.30%
Ash	8.13%
Sulphur	2.42%

This analysis gives a carbon ratio for the coal of 66.74% which shows too high a carbon ratio for commercial pools of oil but still permits gas pools of value. It is possible that some local places within this area may have a lower alteration of the rock beds and in that case oil might be found, but the chances are against the existence of such conditions. The southern portions of this area with a better covering over the oil-gas producing shales offers good chances for commercial gas where structural conditions are favorable.

Area III.—The area marked "3" and by horizontal and vertical lining is practically all of the area between the Ozark Plateau and the Ouachita Mountain system. The outcropping rock beds here belong to the Pennsylvanian series and consist of carbonaceous clay shales, sandstones, and in the western part some workable coal beds. These beds thicken to the southward, probably being four times as thick in the southern part of the area as in the northern part. According to Branner the Pennsylvanian sediments of the state reach a total thickness of 23,780 feet. The strata of this area are folded into many folds and the whole series forms a down warp or synclinorium. As a rule the folds are gentle near the northern border and increase in intensity southward until in places along and near the south border some of the beds stand almost or quite vertical. Metamorphism or alteration of the rock beds has very much kept pace with the intensity of folding. As a rule the highest alteration of the rocks is to the southward and southeastward, but near the heavy faulting, as in the southern part of Scott County, the metamorphism may be somewhat less. Coal analyses are not available for the whole field but the following analyses will give a fair idea of the alteration that has taken place and the way it is distributed:

Locality.	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Carbon Ratio	Analyzed by
Near Bates, Scott Co	3.39	24.44	66.40	5.79	0.87	73	U. S. G. S.
Near Fort Smith	2.19	14.00	72.15	11.66	2.06	84	U. S. G. S.
Hackett	0.85	14.91	73.86	9.03	1.32	83	Brackett
Huntington	1.02	17.88	73.61	7.49	1.10	80	U. S. G. S.
Coal Hill	1.52	14.76	76.91	6.95	1.52	84	U. S. G. S.
Spadra	2.15	10.82	76.87	10.16	2.30	88	U. S. G. S.
Near Russellville	2.33	10.16	77.67	9.40	1.81	88	U. S. G. S.

Many other analyses covering the same territory might be given but they would tell the same story. There are no analyses available covering the eastern or the northern borders of the area but bituminous coals are known to be in those localities, and they may show a less degree of alteration. It is not likely, however, that they will prove sufficiently high in volatile matter to give conditions favorable for oil in commercial quantities. As is well known, this area, in its western part, is already a heavy producer of gas. It is likely that the producing areas may be extended farther eastward along the northern part of the field even to the extreme east border of this area.

Area II.—The area marked "2" on the accompanying map is a part of the gulf coastal plains. The northern part of the area is Cretaceous and the Southern Tertiary in age. The Cretaceous rock beds comprise clays and marls more or less carbonaceous and sandstone, gravel beds, limestone, and chalk, altogether totaling over 2,000 feet in thickness as shown by outcrops. The Tertiary beds are about 1,000 feet thick and consist of sands, clays and marls. Both the Cretaceous and the Tertiary beds dip gently to the southeastward. Both carry beds containing organic matter and porous

sandstone beds. Metamorphic action has not altered the beds to a degree that would destroy oil accumulations. It appears then that the thing most needed for insuring the existence of oil accumulations here is good structural features that would entrap the oil in its upward migrations.

The asphalt deposits in Pike and in Sevier counties show oil leakage along the northern border of the area. This oil must have moved northwards up the slopes of the Cretaceous rock beds. So far as known there are no folds within this area but it is possible that there may be some small folds and furthermore some of the porous beds through which the oil migrates may, in their upward reaches, either thin out and disappear or else become close textured so as to entrap the oil as it moves up the slope of the rock bed.

These last noted conditions can only be proven by the very expensive method of drilling test wells. It is safe to say that oil-bearing areas, under such conditions as exist in this area, must necessarily be small in comparison with the barren areas. The wells that have been drilled in and near this area have indicated a regularity of the dip to the south and southeast and have given no special encouragement for further prospecting.

Area 1.—The area marked "1" comprises nearly all that part of the state lying east and south of the Missouri Pacific Railroad. This area is also a part of the gulf coastal plains. The outcropping rocks are Tertiary and Quaternary in age. The Quaternary beds form a thin covering of alluvial materials lying on the Tertiary beds, along the flood plains of the river bottoms. The Tertiary beds consist of clays, and marls more or less carbonaceous and sandstone and some lignite beds. The strata dip gently toward the southeast. Going eastward over the area one passes over beds that are successively higher and younger geologically and the series becomes thicker until in the southeast part of the state these beds are probably 2,000 feet or more in thickness. Under these beds the Cretaceous beds above noted extend apparently without any breaks.

During Tertiary times the Gulf of Mexico extended over this area in an embayment that reached northward to the southern point of Illinois and is extended to the east of the Mississippi River into Tennessee and Mississippi about as far as it extends westward from the Mississippi River over Arkansas. The underlying and older Cretaceous embayment was somewhat broader, but did not extend quite so far northwards. The embayments gave good conditions for the accumulation of organic matter of the sea and neighboring land areas. Over this area also, with the possible exception of a part of Crowley's Ridge, the rocks have not been altered to a degree that would injure oil accumulations. **The conditions are then favorable for oil and gas wherever structural conditions exist to catch and hold the oil and gas.**

Since the Tertiary rocks are practically all soft and friable they easily go to pieces where exposed at the surface. So a deep soil usually covers the underlying beds and one cannot, except in rare cases, determine from surface examinations how the underlying rock beds lie. Where the top exposed beds lie parallel to the underlying beds and the top beds are well exposed it is a simple process to determine the underground structure so far as folding is concerned. Over this area the rock beds are usually covered and often not well marked when exposed and in places the topmost and the lower beds are not parallel or conformable so it is difficult to determine the structure here.

There is some fairly good evidence of a gentle anticlinal fold extending northeast by southwest through the central part of Cleveland County Should this prove to be true the fold may be expected to extend farther to the northeast and southwest beyond Cleveland County.

While the area marked "1" offers the best chances for finding oil in the State, and while so many of the essential conditions for oil are favorable it should be remembered that sediments laid down along a shore line retreating seaward with a slowly subsiding sea bottom and a rising adjoining land area, as was likely the case, would give rise to beds dipping regularly and not to folds or structural features favorable to entrapping

oil. Favorable structural areas may therefore be expected to form only a small part of the total area.

What the Geologists Say About Oil and Gas Prospects in Different Counties of Arkansas

Arkansas

This county is located in the Coastal Plain region in which the prospects for finding large quantities of oil, particularly if good anticlines or domes can be located, are, perhaps, better than in other portions of the State. Prospect wells have been drilled in several parts of the county, but no production has been reported. The geology of the region is explained in U. S. Geol. Surv. Water Supply Paper 399, Geology and Ground Waters of Northeastern Arkansas.

Ashley

No detailed oil and gas investigations have been made and the State has no information concerning the discovery in that area of any commercial amounts of oil or gas. It would be difficult, if not impossible, to detect from an examination of the surface, anticlines or domes in the buried formations, on account of the heavy mantle of deposits of recent geological age. The geology of the region is explained in Bulletin 429, 1910, "Oil and Gas in Louisiana and Adjacent States," and in Professional Paper 46, 1906, published by the U. S. Geol. Surv.

Baxter

It is the general opinion that the region of Exposed Paleozoric rocks in Arkansas, which embraces Baxter County, offers no promise for the discovering of commercial oil pools because the formations have been too far compressed and altered. Small deposits of natural gas have been found and it is probable that additional supplies will be developed at points of favorable anticlinal or domal structure.

Benton

Detailed descriptions of Benton County are embodied in Geologic Folios 119, 154 and 202. Any commercial amounts of oil encountered in extreme Northwestern Arkansas will probably be in formations of greater geologic age than those yielding oil and gas in Oklahoma and Kansas.

In a description of the Eureka Springs and Harrison quadrangles, by A. H. Purdue and H. D. Miser, published by the U. S. Geological Survey, the following statement is made. "Considerable money has been spent in Northern Arkansas in drilling wells with the hope of finding oil or gas, but neither has yet been found in commercial quantity north of Crawford and Franklin counties. Furthermore, the character of the rocks does not indicate that either oil or gas will be found in commercial quantity in the quadrangles under discussion or in the adjoining parts of Northern Arkansas and Southern Missouri. However, any wells that are put down should be sunk on the domes. Oil may perhaps be distilled from the Chattanooga shale."

Boone

This county is located in the Ozark region, where the formations have been too far altered and compressed to permit the survival of commercial oil pools even if oil were once present. Some natural gas has been discovered in Northwest Arkansas and it is possible that additional supplies will be developed at points of favorable structure. The geology of this region is mapped and described in Geologic Folio 119 and 202.

Bradley

The general geological conditions in this county are similar to those in the southcentral portion of the State, where oil and gas wells have been

developed. Professional Paper 46 discusses the geology and underground water resources of this section and a study of the Coastal Plain region, which embraces Bradley County, would be aided by reference to U. S. Geol. Surv. Bulletin 429, 1910, "Oil and Gas in Louisiana and Adjacent States."

Calhoun

The Coastal Plain region of Arkansas embracing the eastern and southern parts of the State probably offers greater promise for the discovery of commercial quantities of oil than other portions of Arkansas. Professional Paper 46, U. S. Geol. Surv. contains descriptions and a map of the general geology of Northern Louisiana and Southern Arkansas. Favorable indications have induced prospectors to drill for oil at different places in the county, but up to this time there has been no production.

Carroll

This county has been geologically mapped and described in detail in Geological Folio 202, covering the Eureka Springs and Harrison quadrangles. The oil and gas possibilities of the section are briefly discussed. In the opinion of most oil and gas geologists the formations in this region have been too far altered to offer promise for the discovery of commercial pools of oil, though natural gas may be found at points of favorable structure. It is recommended that any wells that may be put down should be sunk on the domes. Oil may perhaps be distilled from the Chattanooga shale.

Chicot

No detailed investigations have been made of the geology or structure of Chicot County, with regard to oil and gas. Information concerning the geology of this county may be obtained from Professional Paper 46, "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas," published by the U. S. Geol. Surv. Chicot County is located in the Coastal Plain region in which the prospects for finding commercial amounts of oil are probably better than in other parts of the State, but there has been made no detailed examinations of the geologic structure in that area with a view to determining the oil and gas possibilitis. In fact that part of Arkansas is so covered by deposits of recent geologic age that an investigation of the surface does not make possible the detection of anticlines or domes favorable to the accumulation of oil and gas in the buried formation in which oil, if present, would be found. The geological conditions in Chicot County are similar to those in Southcentral Arkansas where both oil and gas have been found.

Clark

The geology of Clark County is as varied as is its topography. As will be seen by the Drake Map, a part of this county is included in the most favorable and a part in the most unfavorable area for the finding of oil and gas in the State. There is a persistent belief that these minerals are present and there has recently been active prospecting in the vicinity of Arkadelphia, Gurdon and Whelen Springs.

In the United States Geological Survey Bulletin No. 429, G. D. Harris has the following to say under the heading, "Oil and Gas in Louisiana, with a Brief Summary of their Occurrence in Adjacent States."

"As oil and gas occur in Southern Louisiana and Southeastern Texas in commercial quantities in the vicinity of Saline domes, a few hundred acres in extent, most of such localities being separated by barren regions scores of miles wide, it is highly important for future development that the manner of occurrence of these salines should be carefully studied, so that probably productive territory may be separated from territory in which the discovery of oil or gas is unlikely. * * * In the opinion of the writer, all the saline domes are located along lines of fracture in the deep-lying Mesozoic, and Palezoic rocks, and in general their location seems to be at the crossing of such lines. * * * The large amounts of gas and oil found in the Caddo field, Louisiana, appear to be simply following east and north slopes of a great uplift, and concentrating or reconcentrating along slight anticlinal ridges. * * * Hopes may be entertained of finding oil and gas so

entrapped in wells sunk in various places near the Eocene-Cretaceous contact from Arkadelphia and to beyond San Antonio, Texas."

Clay

The area east of Crowley's Ridge in Arkansas, in fact almost all of Clay County lies in the Coastal Plain region in which the chances for finding commercial pools of oil at points of favorable anticlinal or domal structure are better than in other parts of the State. There has been considerable prospecting lately but up to this time no production of either oil or gas is reported. The geology of this section is explained in Water Supply Paper 399, U. S. Geological Survey.

Cleburne

As this county lies in the area of exposed paleozoic rocks it is the opinion of geologists that the formations have been too far altered to offer promise for the discovery of large amounts of oil, though natural gas may be present at points of favorable structure. The geology of this section is explained and mapped in Geologic Folio 202.

Cleveland

This county is situated in the Coastal Plain region where conditions are regarded as being more favorable for the finding of oil and gas than elsewhere in the State. Dr. John C. Branner and Dr. N. F. Drake, both former State geologists, have made locations for prospect wells in this county. Three wells are now being drilled, two on these locations near Rison and a third near New Edinburg. There is some fairly good evidence of a gentle anticlinal fold extending northeast by southwest through the central part of Cleveland County. Dr. Drake says: "A test well might prove successful at most any depth between 1000 and 4000 feet or even a greater depth. All things considered this area appeals to me to offer a fair chance for success and one that is well worth the taking."

Columbia

This county lies adjacent to Union County in which is located the new El Dorado oil and gas field and it is situated immediately north of the Homer and Haynesville fields in Louisiana, in the Coastal Plains region where conditions are more favorable for the finding of oil and gas than any other part of Arkansas. Several deep wells have been drilled in Columbia County. The geology of the section is explained and mapped in Professional Paper 46, published by the U. S. Geological Survey and in a press bulletin issued by the U. S. Geological Survey on the Eldorado field. Showings of oil were encountered in the Trinity well, Sec. 26, T. 18 S., R. 18 W., and in a well just west of Stephens.

Conway

From what is known concerning the geology of Conway County it may be said that, while natural gas may be found in paying quantities at points of favorable anticlinal or domal structure, it is probable that the formations have been too much altered and compressed in that part of the State to offer promise for the discovery of commercial amounts of petroleum.

The late Dr. A. H. Purdue, former State geologist, expressed the belief that indications were favorable for the extension of the gas field through the Arkansas Valley as far east as Little Rock and recommended the drilling of wells, wherever anticlines occurred in that territory.

Craighead

The general geology of Northeastern Arkansas has been mapped and described in Water Supply Paper 399. There has been no detailed examination of the geological and structural conditions with special regard to oil and gas, and no commercial amounts of oil and gas have yet been found in this area. Craighead County is located in the Coastal Plain region in which the prospects for finding large quantities of oil, at points of favorable anticlinal or domal structure, are probably better than in other portions of the State.

Crawford

Much of Crawford County and a part of Franklin County are embraced in Geologic Folio 154 of the U. S. Geological Survey. Bulletin 541 contains a short report on the Fort Smith-Poteau gas fields, lying partly in this region. There are numerous producing gas wells in the Arkansas River Valley in the southern part of Crawford County. This county lies in the region of exposed paleozoric rocks, which is not regarded by oil and gas geologists in general as favorable for the occurrence of large amounts of oil on account of the advanced stage of alteration of this formation. An explanation of the failure to find oil in the Western Arkansas gas field is offered by Dr. David White who estimates that where the fixed carbon content of the coal is 65% the oils which may formerly have been present in the same or underlying formations have mostly disappeared and that where coal shows a carbon ratio of 70% oil will not be found in commercial quantities though gas pools may be present.

Crittenden

This county lies in the Coastal Plain region where the prospects are most favorable for the presence of oil and gas but the county is covered by deposits of recent geologic age; thus it is difficult to detect indications favorable for the accumulation of these minerals in the buried formation. The general geology of this section is mapped in Water Supply Paper 399, "Geology and Ground Waters of Northeastern Arkansas."

Cross

If favorable anticlines or domes can be located either on Crowley's Ridge, or in the valleys on the east and west sides of the ridge, it is probable that oil deposits will be found in Cross County as it is a part of the Coastal Region in which the prospects for discovery of commercial oil pools are probably better than in other parts of the State. It is difficult to detect indications favorable for the accumulation of oil and gas for the reason that especially in the valley sections the region is covered by deposits of recent geologic age. The general geology of this section is mapped in Water Supply Paper 399, "Geology and Ground Waters of Northeastern Arkansas."

Dallas

Favorable indications have induced the drilling of deep wells at Fordyce and other points in Dallas County but so far without discovering either oil or gas in commercial amounts. This county is in the heart of the Coastal Plain region, which geologists think offers greater promise for the discovery of oil than other portions of the State. The geology of this section is explained in U. S. Geological Survey Professional Paper 46, "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas."

Desha

The counties bordering on the Arkansas River in the eastern part of the State have not been examined in detail with regard to oil and gas possibilities, but they are included in the Coastal Plain region of Arkansas in which the prospects for finding commercial quantities of oil at points of favorable structure are probably better than in other parts of the State. U. S. Geological Survey Paper 46 describes the geology and underground resources of Southern Arkansas.

Drew

No detailed oil and gas investigations have been made and the State has no information concerning the discovery in that area of any commercial amounts of oil and gas. Drew county lies in the Coastal Plain region of Arkansas, in which the prospects for finding commercial amounts of oil, if favorable anticlines or domes can be located, are probably better than in other parts of the State. The general geology of Drew County is mapped and described in Professional Paper 46, "The Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas." It would be difficult, if not impossible, to detect, from an examination of the surface,

anticlines or domes in the buried formations, on account of the heavy mantle of deposits of recent geologic age. Several deep wells are being drilled on the Monticello Ridge near the city of Monticello.

Faulkner

This county lies in the area of exposed paleozoic rocks where, it is believed, the formations have been too far altered and compressed to be favorable for the occurrence of commercial oil pools, though natural gas may be present at points of favorable anticlinal or domal structure. No report has been published dealing with oil and gas conditions in this region. The formations outcropping in this part of the Ozarks are of greater geologic age than those in which oil and gas have been found in commercial quantities in this country, especially in the Mid-Continent fields. The late Dr. A. H. Purdue, former State geologist, expressed the belief that indications were favorable for the extension of the gas field through the Arkansas Valley as far east as Little Rock and recommended the drilling of wells wherever anticlines occurred in that territory.

Franklin

A small part of Franklin County is embraced in Geologic Folio 154, published by the U. S. Geological Survey. Although there is a production of natural gas in the adjoining county of Crawford and a showing of oil has been reported as being found in shallow wells at Ozark, there has been no commercial production. This part of the State lies in the region of exposed paleozoic rocks and is not regarded by oil and gas geologists in general as favorable for the occurrences of large amounts of oil on account of the advanced stage of alteration of the formations. Deep wells have been drilled in different parts of the county, so far, without results. One of these tests was in a well located anticline where there was thought to be possibilities of oil in the lower part of the Pennsylvania formation. There is also a favorable anticline at Jethro in the northern part of the county.

Fulton

This county lies in the area of exposed paleozoic rocks, where, in the opinion of most oil and gas geologists, the formations have been too much altered to offer promise for the discovery of commercial amounts of oil.

Garland

This region is treated geologically in U. S. Geological Survey Bulletin 691-J, "Asphalt Deposits and Oil Conditions in Southwestern Arkansas." Garland County is in the area of exposed paleozoic rocks in which, in the opinion of most oil and gas geologists, the formations have been too far altered to offer promise for the discovery of commercial pools of oil. There has been no detailed examination of the geology or structure with regard to oil and gas possibilities. There is no possibility that either oil in commercial quantities or gas in large pools will be found in the Ouachita Mountain region of west-central Arkansas. The Carboniferous and older rocks have been so highly tilted and so much fractured and metamorphosed that if oil or gas were ever present in them the gas and much of the oil would have made their escape to the surface and the remainder of the oil would have been distilled to asphalt.

Grant

This county lies within the Coastal Plain region where conditions are more favorable than elsewhere in the State for the accumulation of oil and natural gas and there is encouragement for prospecting where anticlines and domes can be located. The geology of this section is explained in Water Supply Paper 46, published by the U. S. Geological Survey. There has been no detailed survey for oil and gas and no commercial production of either mineral has been reported though several deep wells are now being drilled in the county.

Greene

The general geology of Northeastern Arkansas has been mapped and described in Water Supply Paper 399. There has been no detailed examin-

ation of the geological and structural conditions with special regard to oil and gas and no commercial amounts of oil and gas have yet been found in this area. Greene County is located in the Coastal Plain region in which the prospects for finding large quantities of oil at points of favorable anticlinal or domal structure, are probably better than in other portions of the State.

Hempstead

This county lies in the Coastal Plain region where the prospects for the discovery of commercial amounts of oil, especially if anticlines or domes can be located there, are probably better than in other parts of the State. A small map showing the geology of Hempstead County is included in Bulletin 691-J, "Asphalt Deposits and Oil Conditions in Southwestern Arkansas," published by the U. S. Geological Survey. Several deep wells have lately been drilled into what is regarded as favorable structure in the vicinity of Hope but there has as yet been no commercial production of either gas or oil.

Hot Spring

The general geology of Hot Spring County has been described and mapped in Professional Paper 46, "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas." This county lies partly in the Coastal Plain region and partly in the area of exposed paleozoic rocks, the first being regarded as favorable and the second unfavorable for the accumulation of oil and gas. A deep well was drilled near Gifford but did not encounter either mineral.

Howard

The southern part of Howard County lies in the Coastal Plain region and if local anticlines or domes could be located, it is possible that commercial quantities of oil may be found there. Bulletin 691-J, published by the U. S. Geological Survey deals with the asphalt deposits and oil possibilities of this section. The Cretaceous rocks in Southwestern Arkansas have a southward dip of about 100 feet to the mile and, although they have been slightly warped, no pronounced anticlines or synclines occur in Pike, Howard and Sevier counties. Thus if petroleum occurs in the region south of the asphalt deposits, its accumulation into quantities of possible commercial importance would probably be controlled by terrace structure, lanticular character of sands or irregularities in the Cretaceous floor.

Independence

Small amounts of natural gas have been encountered in wells in the vicinity of Batesville and it is regarded as probable that favorable structure embracing Upper Mississippian formations may give gas in commercial amounts especially on the south side of White River. The formations in this part of Arkansas, it is believed, have been too far altered to be favorable for the occurrence of large quantities of oil. Geological conditions north and northwest of Batesville are described in Bulletin 715-G, U. S. Geological Survey. An examination in the vicinity of Batesville was made by the U. S. Geological Survey several years ago but no report was published for the reason that the conditions were not encouraging from the standpoint of oil prospects, although hardly discouraging with reference to possible development of natural gas in small supplies. It is the opinion that the alterations of the rocks in the Batesville district has probably progressed too far to offer promise for the discovery of commercial oil pools, though natural gas may be present in paying quantities at points of favorable structure—folds or anticlines.

Izard

It is the opinion of geologists that the region of exposed paleozoic rocks in Arkansas, which embraces Izard County, offers no promise for the discovery of commercial oil pools because the formations have been too far compressed or altered. Small deposits of natural gas have been found and it is probable that additional supplies will be developed at points of favorable anticlinal or domal structure.

Jackson

Newport, the seat of Jackson County, is located on the border of the Coastal Plain. To the eastward the conditions are favorable for the discovery of oil. To the westward there are indications of natural gas, but not of oil in commercial amounts although oil seepages have been encountered. The geology of the region is explained in U. S. Geological Survey Water Supply Paper 399 and the report of a special survey of the Batesville district, known as U. S. Geological Survey Bulletin 715, will prove of special interest in a study of the oil and gas geology of Jackson County.

Jefferson

No survey for oil and gas has been made of Jefferson County. This being a part of the Coastal Plain region it is believed that the presence of oil and gas may be expected where the structure is favorable. The general geology of this section is described in Professional Paper 46, published by the U. S. Geological Survey. Also in Water Supply Paper 399. Considerable drilling has been done in Jefferson County. In a well sunk several years ago at Faith, in T. 75, R. 10 W. it is reported that a showing of oil was encountered at a depth of 2231 feet, but the test was abandoned at a depth of 2541 feet. On account of the covering of deposits of a recent geologic age, the detection of local anticlines or domes, favorable for the accumulation of oil or gas, in the buried formations, is difficult if not impossible from an investigation of surface criteria.

Johnson

Johnson County lies in the area of exposed paleozoic rocks in which, in the opinion of geologists, the formations have been too far altered and compressed to offer promise for the discovery of commercial amounts of oil, though natural gas has been found in this region and additional supplies will probably be developed at points of favorable anticlinal or domal structure. U. S. Geological Survey Bulletins 326 and 427 deal with the geology of this region. Gas was reported to have been found at 2260 feet on the J. W. Pierson farm, five miles northwest of Clarksville (22-10-24), in November, 1921.

Lafayette

Geological conditions especially favor Lafayette County in the matter of oil and gas development, it being situated contiguous to both the El Dorado field in Arkansas and the Caddo field in Louisiana and is embraced in the Coastal Plain region where geologists concede the best chances exist for finding oil and gas in Arkansas. Several wells have been drilled but so far there has been no production in this county. The geology of Lafayette County is explained in Professional Paper 46, published by the U. S. Geological Survey and in Bulletin 691-J, "Asphalt Deposits and Oil Conditions in Southwestern Arkansas," also published by the Survey, there is a good deal of information about conditions generally in Southwest Arkansas.

Lawrence

The general geology of this part of Arkansas has been mapped and described in Water Supply Paper 399. There has been no special survey for oil and gas. The eastern part of Lawrence County is located in the Coastal Plain region in which the prospects for finding large quantities of oil at points of favorable anticlinal or domal structure, are probably better than in other portions of the State. Western Lawrence County is in the area of exposed paleozoic rocks in which, in the opinion of most oil and gas geologists, the formations have been too much altered to offer promise for the discovery of large amounts of oil, though natural gas may be present where the structure is favorable.

Lee

Owing to the heavy deposits of a recent geologic age it is difficult from a study of the surface conditions to detect favorable locations, in Lee

County, for the accumulation in the buried structure, of oil and gas in commercial amounts. The whole county lies in the Coastal Plain region where conditions are regarded as more encouraging than in other parts of the State. The geology of this district is explained and mapped in U. S. Geological Survey Water Supply Paper 399, "Underground Waters of Northeastern Arkansas.

Lincoln

This section has not been examined in detail with regard to oil and gas but it lies in the Coastal Plain region in which the prospects for finding commercial quantities of oil at points of favorable structure are probably better than in other parts of the State. U. S. Geological Survey Paper 46 describes the geology and underground resources of Southern Arkansas.

Little River

Since the geological and strategraphic conditions in Little River County are similar to those in the producing oil and gas fields of Northwestern Louisiana (and Southern Arkansas) it seems probable that commercial amounts of oil and gas will be found in the county if favorable anticlines or domes can be located. However, no detailed examinations have been made to determine the local structural conditions and, in fact, any such determination would be difficult if not impossible, on account of the covering of deposits of recent geologic age which conceals the structure of the underlying formations. The general geologic features of Little River County are shown in a map included in U. S. Geological Survey Bulletin 691-J, "Asphalt Deposits and Oil Conditions in Southwestern Arkansas."

Logan

Some information concerning the geology and broad structure of Logan County is given in Bulletin 326, a report on the Arkansas coal field. Logan County is embraced in the coal field area of Arkansas, in which in the opinion of most oil and gas geologists the formations have been too far altered and compressed to be favorable for the occurrence of oil in commercial amounts, though natural gas has been found and it is probable that additional supplies will be developed at points of favorable anticlinal or domal structure. Deep wells have recently been drilled near Booneville and Magazine but no production of oil has been reported.

Lonoke

The geology of this part of Arkansas is discussed quite fully in Water Supply Paper 399. There has been no detailed investigations to determine the oil and gas prospects. Lonoke County is located in the Coastal Plain region in which the prospects for the discovery of commercial quantities of oil, at points of favorable anticlinal or domal structure, are probably better than in other parts of the State. Dr. John C. Branner, former State geologist, made the location for a prospect oil well which at this writing is being drilled in the vicinity of England.

Madison

Detailed descriptions of the northern half of Madison County are embodied in Geologic Folios 119, 154 and 202. Any commercial amounts of oil encountered in extreme Northwestern Arkansas will probably be in formations of greater geologic age than those yielding oil and gas in Oklahoma and Kansas. In the opinions of most oil and gas geologists the formations in this region have been too far altered to offer promise for the discovery of commercial pools of oil, though natural gas may be found at points of favorable structure.

Marion

The formations in this section have been too far altered and compressed to permit the survival of commercial oil pools, even if oil once were present. Some natural gas has been discovered in Northwest Arkansas and it is possible that additional supplies will be developed at points of favorable structure. The geology of this region is mapped and described in Geologic Folios 119 and 202.

Miller

The geology of Southwestern Arkansas is discussed in U. S. Geological Survey Bulletins 661-C, 690-B and 691-J. The first bulletin contains some information regarding the Sabine Uplift including a map showing its location and partial extent. It also describes the Trinity sand and strata of Eocene age. Bulletin 691-J discusses the asphalt deposits and oil conditions and gives information concerning the Trinity formation in Southwestern Arkansas. Numerous wells have been drilled in Miller County without any production so far being reported.

Mississippi

This county lies in the valley between two great rivers, the Mississippi and the St. Francis and the entire surface is covered with many feet of alluvial soil brought down in recent years from the water sheds of these streams. It is therefore difficult if not impossible to detect from surface indications the locations most favorable for the accumulation in the buried deposits of commercial amounts of oil and gas. The whole county lies in the Coastal Plain region where conditions are regarded as being more favorable than elsewhere in the State. The geology of Mississippi County is explained in U. S. Geological Survey Water Supply Paper 399.

Monroe

The Coastal Plain region, embracing Monroe County, offers the greatest promise for the discovery of commercial amounts of oil and there is encouragement for the drilling of wells at points where a favorable structure is to be found. The geology of this section is explained in U. S. Geological Survey, Professional Paper 46.

Montgomery

This county lies in the area of exposed paleozoic rocks in which in the opinion of most oil and gas geologists the formations have been too far altered to offer promise for the discovery of commercial pools of oil, though gas may be found at points of favorable anticlinal or domal structure. The geology of this general section is discussed in U. S. Geological Survey Bulletin 691-J. There has been no detailed examination of the geology or structure with regard to oil and gas possibilities.

Nevada

This county lies in the Coastal Plain region in close proximity to the producing El Dorado field. The geologic map shows the area about equally divided between the Quaternary, Tertiary and Cretaceous formations. The geologists say that metamorphic action has not altered the beds to a degree that would destroy oil accumulations and in favorable anticlinal and domal situations it may reasonably be expected that oil and gas would be found in Nevada County. The geology of the section is explained in U. S. Geological Survey Bulletin 691-J, "Asphalt Deposits and Oil Conditions in Southwestern Arkansas." Several deep wells have been drilled in the vicinity of Prescott but no production of either oil or gas is reported at this time.

Newton

This county is located in the area of exposed paleozoic rocks in which in the opinion of most oil and gas geologists, the formations have been too far altered to offer promise for the discovery of large amounts of oil, though natural gas may be present at points of favorable structure. The geology of this section is explained and mapped in Geologic Folio 202. The outcroppings in the Ozark region are of greater geologic age than those in which oil and gas have been found in commercial quantities in this country, especially in the Mid-Continent field.

Ouachita

This county is in the Coastal Plain region which embraces the eastern and southern parts of the State, including Union County where oil and gas have recently been developed. Before the bringing in of the discovery

well in El Dorado a showing of oil was reported from the Hunter well located near Stephens and for a time there was a good deal of activity in the buying and selling of leases in the neighborhood. It was reported that one of the large oil syndicates obtained control of the field. There has since been no new drilling and no oil is being produced at this time. At Chidester and other places in the county efforts also have been made to find oil and gas. The geology of the region is explained in U. S. Geological Survey Bulletin 429, 1910, "Oil and Gas in Louisiana and Adjacent States," and in Professional Paper 46, 1906, U. S. Geological Survey.

Perry

No examination of the geology and structure of Perry County has been made with a view to determining the oil and gas possibilities in that area. The county lies in the region of exposed paleozoic formations in which, in the opinion of most oil and gas geologists, the formations have been too much altered to offer promise for the occurrence of commercial oil pools. It is, however, possible that natural gas may be found if favorable anticlines or domes can be located. The fact that several hundred wells drilled in the paleozoic region of Arkansas have failed to encounter commercial amounts of oil constitutes important evidence as to the improbability of finding such deposits there.

Phillips

This is a typical "bottom land" county on the Mississippi River front and, except for the tertiary projection known as Crowley's Ridge, the whole area is covered by sediment brought down in recent times by the great river and its tributaries. These deposits covering as they do the Quaternary beds prevent a study of the structure where it would be expected that oil and gas might accumulate and knowledge will be gained only by the drilling of prospect wells where conditions seem most favorable. This being a part of the Coastal Plain region the geologists agree that the indications are as favorable for finding oil and gas in Phillips County as in any other part of the State.

Pike

The geology of this section is mapped and discussed in U. S. Geological Survey Bulletin 691-J describing the asphalt deposits and oil conditions of Southwestern Arkansas, embracing Pike County. The presence of asphalt in Pike and Sevier counties has from time to time attracted the attention of those interested in oil development and a few wells have been sunk with the hope of finding oil, but thus far oil has not been found in commercial quantity. The Trinity formation which covers a part of the county contains petroleum and asphalt at many places in Northern Texas and Southwestern Oklahoma. The petroleum yielding the asphalt in Arkansas is believed to have been derived from the carboniferous rocks underlying the Trinity formation near the base of which the asphalt is found.

The Cretaceous rocks in Southwestern Arkansas have a southward dip of about 100 feet to the mile, and although they have been slightly warped, no pronounced anticlines or synclines occur in Pike, Howard and Sevier counties. Thus, if petroleum occurs in the region south of the asphalt deposits, its accumulation into quantities of possible commercial importance would probably be controlled by terrace structure, lenticular character of sands, or irregularities in the Cretaceous floor.

Poinsett

This county lies in the Coastal Plain region in which the prospects for discovering commercial oil pools are probably better than in other parts of Arkansas. If favorable anticlines or domes can be located it is probable that oil deposits will be found there. The region is covered by deposits of recent geologic age, so that it is difficult, if not impossible, from an examination of the surface, to detect indications favorable for the accumulation of oil and gas in the buried formation. The general geology of this section is mapped in Water Supply paper 399, "Geology and Ground Waters of Northeastern Arkansas." There has recently been considerable prospecting in the vicinity of Harrisburg, but so far no production is reported.

Polk

This county is located in the area of exposed paleozoic rocks in which, in the opinion of most oil and gas geologists, the formations have been too much compressed and too far altered to offer promise for the discovery of commercial pools of oil, although it is possible that natural gas might be found at points of favorable anticlinal or domal structure. The general geological features of the area are shown on a map included in Bulletin 691-J, relating to asphalt deposits and oil conditions in Southwestern Arkansas.

Pope

This county lies in the area of exposed paleozoic rocks, in which, in the opinion of geologists, the formations have been too far altered and compressed to offer promise for the discovery of commercial amounts of oil, though natural gas has been found in the region and additional supplies will probably be developed at points of favorable anticlinal or domal structure. U. S. Geological Survey, Bulletin 326, pertaining to the coal fields of the State, gives information regarding the geology of this section.

Prairie

Included in the Coastal Plain region, Prairie county is thought to have favorable chances for finding oil and gas in commercial quantities, but there has been no detailed survey with special reference to these minerals and very little is known as to the location of favorable anticlines or domes. The general geology of the region is explained in Professional Paper 46, U. S. Geological Survey, and in Water Supply Paper 399, by the same survey, the latter dealing with the geology and underground waters of Northeastern Arkansas.

Pulaski

With the exception of the southeastern corner Pulaski County lies in the area of exposed paleozoic rocks in which it is thought that the formations have been too much altered and compressed to offer promise of the survival of commercial pools of oil, even if oil was once present. The southeastern corner of the county is in the Coastal Plain region in which the prospects of finding commercial amounts of oil are better than in other parts of the State but no survey has been made to determine whether the formations are of sufficient aggregate thickness or have been folded into domes or anticlines so that they offer conditions favorable for the occurrence of commercial oil pools. Several deep wells have been drilled without encountering either oil or gas. It is believed that the Western Arkansas gas field may be found to extend eastward as far as Little Rock.

Randolph

No detailed examination has been made of the geological and structural features of Northeastern Arkansas, with regard to oil and gas possibilities, and no commercial amounts of oil have been found in Randolph County. The general geology of this section has been mapped and described in U. S. Geological Survey Water Supply Paper 399. A portion of the southeastern part of Randolph County lies in the Coastal Plain region which probably offers greater promise for the discovery of commercial oil pools than other portions of the State. The region of exposed paleozoic rocks is regarded as unfavorable for the accumulation of oil in commercial quantities but it is possible that natural gas may be found here, where the structure is favorable.

Saline

In the area of exposed paleozoic rocks in Arkansas, embracing most of Saline County, it is probable that the formations have been too greatly compressed and altered to offer promise for the discovery of commercial amounts of oil, though natural gas may be present at points of favorable anticlinal or domal structure. The geology of this general section is discussed in Bulletin 429, U. S. Geological Survey, "Oil and gas in Louisiana and adjacent States," and Bulletin 691-J, "Asphalt Deposits and Oil Conditions of Southwestern Arkansas," also published by the Survey.

Scott

A part of this county lies in the natural gas belt of Western Arkansas. Bulletin 326, which is a report on the Arkansas coal field, describes the geology of parts of Scott and Yell counties. Bulletin 541 contains a report of the Fort Smith-Poteau gas field, and describes the geology of the northern part of Scott County. It is the opinion of most oil and gas geologists that the formations in that part of Arkansas embracing Scott County have been too far altered by regional metamorphism to offer promise for the discovery of oil in commercial amounts, although it is probable that additional supplies of natural gas will be found at points of favorable anticlinal or domal structure. A showing of oil was obtained in a well drilled to a depth of 2700 feet near Waldron some years ago but the well did not prove a producer.

Searcy

Information regarding the general geology of Searcy County is given in Water Supply Paper 399. There has been no detailed investigations such as are essential to any determination of oil or gas prospects in this county. Searcy County lies in the region of exposed paleozoic rocks in which, according to the opinion of most oil and gas geologists, the formations have been too far altered to offer promise for the discovery of commercial oil pools. Natural gas may be found in the region, in anticlines and domes, where the folding has not been too severe.

Sebastian

The Fort Smith-Poteau gas field has been mapped and describel by the U. S. Geological Survey in Bulletin 541. If favorable anticlines or domes can be located in this part of the State it is probable that additional gas supplies may be developed.

The first gas well was drilled in Arkansas on the Massard Prairie, south of Fort Smith in 1901. The producing field at present extends north and south of the Arkansas River, from near Alma on the east to Poteau, Oklahoma, embracing parts of Crawford, Sebastian and Scott counties. The production of natural gas in this field from wells drilled in 1919 exceeded 200,000,000 cubic feet a day. One well has a record of 24,000,000 cubic feet a day and is rated as one of the largest in the Southwest.

Gas is found at depths of from 750 to 3175 feet. There are seven distinct producing sands, each from 40 to 280 feet thick. The product is dry, clean and odorless. Under government test this gas shows a heating record of 1057 British thermal units, which is considerably higher than the tests made by most gases from the Southwestern field.

Five companies are operating in the Arkansas field and pipe lines are laid from the wells to nearby cities for distribution to more than 100 industries and thousands of private homes.

The following analysis of natural gas from the Kibler field in Crawford county is furnished to the department by Mr. Walter D. Van Sickel, general manager of the Southwestern General Gas Company, Fort Smith, Ark.

Carbon Dioxide	0.14%
Oxygen	0.06%
Methene	97.60%
Ethane	1.70%
Residue	.50%
Total	100.00%

Heating value:

Gross	1070 B. T. U.
Net	971 B. T. U.

As to oil prospects in the Western Arkansas natural gas field, Dr. Drake, former State geologist, says:

"Metamorphism has for a long time been recognized as a means of destroying oil accumulations. It offers what is apparently the best explanation for not finding oil in the Kibler, Massard Prairie and neighboring gas fields of Western Arkansas."

Sevier

The geological and stratagraphic features of Southwestern Arkansas are similar to those in the producing oil and gas field of Northwestern Louisiana (and Southern Arkansas) and if favorable anticlines or domes can be located in the former region it is probable that commercial amounts of oil and gas will be found there. No commercial amounts of oil or gas have yet been found in Sevier County although traces of both have been encountered. Information concerning oil and gas conditions in this part of Arkansas are included in U. S. Geological Survey Bulletin 691-J, "Asphalt Deposits and Oil Conditions in Southwestern Arkansas," which says: "The Cretaceous rocks in Southwestern Arkansas have a southward dip of about 100 feet to the mile and, although they have been slightly warped, no pronounced anticlines or synclines occur in Pike, Howard and Sevier counties. Thus if petroleum occurs in the region south of the asphalt deposits its accumulation into quantities of possible commercial importance would probably be controlled by terrace structure, lenticular character of sands or irregularity in the cretaceous rock. A flow of gas was obtained near DeQueen in 1918.

Sharp

The general geology of Sharp County is shown on a map included in Water Supply Paper 399, "Geology and Ground Waters of Northwestern Arkansas." No commercial amounts of oil have been found in that part of Arkansas and it is the general opinion that the formations have been too far altered and too greatly compressed to offer promise for the discovery of oil pools, though natural gas may be found at points of favorable anticlinal or domal structure.

St Francis

Except for Crowley's Ridge, which extends north and south through the center of St. Francis County, it is difficult to study the geology of this district and its relation to the development of oil and gas for the reason that the greater part of the county, east and west of the ridge is overlaid by deposits of a recent geological age, preventing a study of the buried formations in which it may be expected that these minerals will be found. The county is in the Coastal Plain region which is regarded as being favorably situated for the accumulation of oil and gas. The geology of the district is explained in U. S. Geological Survey Water Supply Paper 399.

Stone

Geologists seem to agree that the region of exposed paleozoic rocks in Arkansas, which embraces Stone County, offers no promise for the discovery of commercial oil pools for the reason that the formations have been too far compressed and altered. Small deposits of natural gas have been found and it is probable that additional supplies will be developed at points of favorable anticlinal or domal structure.

Union.

The Eldorado oil and gas field is fully described in a special bulletin compiled by the U. S. Geological Survey later to be published by the Arkansas Bureau of Mines, Manufactures and Agriculture. The following is taken from an advance press bulletin issued by the Survey prior to the completion of the discovery well on Jan. 10, 1921.

"The formations in Southern Arkansas are practically identical with those that yield oil and gas in Northern Louisiana and the location of the area, with relation to the Ouachita and Saline uplifts, indicates that there is in that area favorable anticlinal structure comparable to the anticlines beneath which the Caddo and Homer pools were formed. Most important of all, oil and gas have been actually found, the first strike occurring in the Spring of 1920 in the Constantin Refining Company's well about four miles southwest of Eldorado, when a flow of gas estimated at from 10,000,000 to 100,000,000 cubic feet a day and a spray of oil was obtained."

Since this time more than 598 producing oil wells and 30 gas wells have been completed and this development has centered attention in Union, Col-

umbia and Ouachita counties, though LaFayette, Nevada, Bradley and Ashley counties are also regarded as containing favorable areas.

"The surface formations are principally sands, gravels and clays of Pleistocene age and clays and sandstones of the Claiborne group, of Eocene age. Many of the clay beds are "gumbo," red to brown in color, with no evident fissility or bedding that will aid in deciphering the structure. Others are gray and are platy, with strikingly marked stratification. There are also a few buff to tan clays, which contain lenses of coarse gravel. The gray and brown clays and shales at many places contain a large percentage of microscopically fine sand and behave like sandstones in revealing the work of currents by cross-bedding, so that what seems to be structural dips must be carefully examined before they are accepted as such. * * *

"The existence of anticlinal structure is indicated by pronounced dips that can be seen in the railroad cuts and along roads through the district. The observable dips are not sufficiently numerous to reveal the extent and exact outlines of the folds, but careful work will doubtless disclose other criteria that may be used in outlining them. In some places the dips are so steep that they are possibly due to slumping or faulting rather than to folding, and there is undoubtedly some cross-bedding, but even after these doubtful areas are ruled out of consideration there remain enough good exposures in which reliable observations can be made to make it certain that there are anticlinal folds whose flanks dip from one-half to six degrees. These pronounced dips indicate that the folds will be large, as sharp dips on small structural features are rare. * * *

"The evidence available indicates that southwestern Arkansas is one of the most promising undeveloped regions, and it is hoped that prospecting will proceed until its potentialities are fully revealed."

El Dorado Production in 1921.

In the El Dorado field there are 589 producing wells having in 1921 a total production of 11,672,480 barrels, of the value of $23,344,960. The development by months was as follows:

WELL RECORD

	Completed	Oil	Gas	Dry	Barrels Sold
January	9	1	2	6	No Sales
February	4	4	....	....	No Sales
March	15	12	1	2	No Sales
April	25	19	3	3	No Sales
May	58	51	4	3	930,000
June	98	90	3	5	1,168,350
July	76	71	3	2	1,596,500
August	97	91	4	2	1,948,753
September	76	70	1	5	1,437,730
October	90	83	3	4	1,355,847
November	41	31	5	5	1,830,800
December	83	75	3	5	1,404,500
Total	672	598	32	42	11,672,480

Analysis of El Dorado Crude.

Reported by U. S. Geological Survey, Sample Number 716, State of Arkansas, El Dorado Field, Union County.

Specific gravity, 0.852
Per cent sulphur, 0.83
Baumé gravity, 34.3°
Per cent water, 0.1
Saybolt Universal viscosity at 70° F.—57.0
Saybolt Universal viscosity at 100° F.—46.6
Pour test, below 5° F.

Distillation, Bureau of Mines Hempel Method.

Air distillation, Barometer, 749 mm. First drop, 31° c. (88° F.)

Temp. °C	Pct. Cut	Sum Pct.	Sp. Gr. Cut	°B. Cut	Viscosity	Cloud Test °F	Temp. F°
Up to 50							Up to 122
50– 75	4.5	4.5	0.680	75.9			122–167
75–100	4.2	8.7	.701	69.7			167–212
100–125	7.1	15.8	.722	63.9			212–257
125–150	6.2	22.0	.746	57.7			257–302
150–175	5.1	27.1	.772	51.3			302–347
175–200	3.6	30.7	.795	46.1			347–392
200–225	3.5	34.2	.810	42.8			392–437
225–250	4.4	38.6	.823	40.1			437–482
250–275	5.1	43.7	.833	38.1			482–527
Vacuum distillation at 40 mm.—							
Up to 200	5.5	5.5	.853	34.1	40	18	Up to 392
200–225	6.5	12.0	.860	32.8	45	30	392–437
225–250	5.9	17.9	.874	30.2	60	52	437–482
250–275	5.4	23.3	.890	27.3	81	72	482–527
275–300	4.6	27.9	.903	25.0	132	91	527–572

Carbon residue of residuum—10.3%.

Approximate Summary.

	Per cent.	Sp. Gr.	°B.
Gasoline and naphtha	30.7	0.735	60.5
Kerosene	13.0	.823	40.1
Gas oil	12.0	.857	33.4
Light lubricating distillate	11.3	.882	28.7
Medium lubricating distillate	4.6	.903	25.0

Van Buren

Formations outcropping in Van Buren County are of greater geological age than those in which oil and gas have been found in commercial quantities in this country, especially in the Mid-Continent fields. This county is in the area of exposed paleozoic rocks where it is the opinion of geologists that the formations have been too far altered to offer promise for the discovery of large amounts of oil though natural gas may be present at points of favorable structure. The geology of this section is explained and mapped in Geologic Folio 202.

Washington

Any commercial amounts of oil encountered in extreme Northwestern Arkansas will probably be in formations of greater geologic age than those yielding oil and gas in Oklahoma and Kansas. Detailed descriptions of the eastern edge of Washington County are embodied in Geologic Folios 119, 154 and 202. A well 300 feet deep located four miles northwest of Fayetteville has for several years furnished gas fuel for cooking and heating at a farm house.

The occurrence of oil and gas in the vicinity of Fayetteville has led many to the expectation that something substantial might be realized from it. But the oil indications are based solely upon the occurrence of petroleum in small quantities in the Fayetteville shale, and the gas thus far discovered is evidently from the same source, and likewise of small quantity. Oil may occur in the rocks of any geological horizon, and the mere fact of its presence is not, as many suppose, prima facie evidence of the existence of petroleum in paying quantities. The Fayetteville shale has been pretty thoroughly explored, and there is no substantial reason for expecting it to prove a source of oil.

It may be well in this connection to correct an error in regard to the relation of the structural geology of this part of the State to this oil-satur-

ated rock on Cove Creek. It has been thought that the rocks in the Boston Mountains dipped north forming a basin in the central or northern part of Washington County, and that the oil-bearing rocks exposed on Cove Creek would therefore be found at a considerable depth in Benton County and in Northern Washington County, and rich in oil. This is a grave mistake. The general dip of the rocks through the Boston Mountains is to the south, though there are many local dips in other directions.

White

Water Supply Paper 399 contains a geologic map of White County and describes the geology of the southeast half of this county. White County is located on the border between the area of paleozoic rocks and the Coastal Plain region. In the former region, it is probable that the formations have been too far altered and compressed to be favorable for the occurrence of commercial oil pools though natural gas may be present at points of favorable anticlinal or domal structure. The Coastal Plain region probably offers greater promise than other parts of the State for the discovery of oil in paying quantities but it is not known whether the formations of the Coastal Plain in White County are of sufficient thickness in the aggregate to offer favorable conditions for the occurrence of commercial amounts of oil. Deep wells have recently been drilled in the vicinity of El Paso and near Judsonia without success in the efforts to find oil.

Woodruff

This county lies in the Coastal Plain region in which the prospects for finding commercial amounts of oil, if favorable anticlines or domes can be located, are better than in other parts of the State. However there has been no investigation of the geological and structural conditions in that county in sufficient detail to gain any knowledge as to the presence of local anticlines or domes in the buried formations in which oil and gas, if present, would be encountered.

Yell

Bulletin 351 contains a geologic map of Arkansas and brief descriptions of the geology of Yell County. The larger number of wells that have been drilled in the region of exposed paleozoic rocks, some of which are in Yell County, and their failure to encounter commercial amounts of oil constitutes important evidence as to the improbability of finding such deposits there, the geologists think. It is possible that natural gas may be found in this part of the State where favorable anticlines or domes can be located.

Tanks Loaded with Arkansas Oil in El Dorado Yards.

Pearls

Precious pearls are procured from the fresh water mollusca of White and Black Rivers in North Arkansas and occasionally from Little River in Southwest Arkansas. The Arkansas pearls are of rare quality in color and an unusually high per centage are perfectly shaped. Frequently gems are found that bring from $300 to $2,500 each.

The pearl-bearing shells are extensively used in the manufacture of pearl buttons, being dredged from the bottom of the streams by specially designed boats manned by expert fishermen. Tons of these mollusca are marketed annually at Black Rock, Newport, DeValls Bluff and Clarendon, where there are plants for the production of the pearl buttons of commerce.

Perofskite

Titanic and calcium oxides. In cubes, octahedrons, etc., and fine twin crystals. Magnet Cove.

Phosphates

The developed phosphate deposits of Arkansas are on Lafferty Creek, on the western edge of Independence County. The only point at which the beds are now worked is about three-fourths of a mile east of White River and the same distance from the White River branch of the Missouri Pacific Railroad. Although this is the only locality at which the deposits have been developed, they have a wide east-west extent, reaching from the town of Hickory Valley, ten miles northeast of Batesville, westward at least as far as St. Joe, in Searcy County, a distance of more than 80 miles. A phosphate bed, which is practically horizontal, outcrops in a winding line on the hillsides and in other places between the points mentioned. A phosphoric horizon can be traced to the westward border of the state, but at no point west of St. Joe have phosphate rocks, in considerable amount, attracted the attention of geologists. Thin layers of phosphatic sandstone are found in the Devonian shales in the western part of Carroll County, on War Eagle Creek.

The following analyses of specimens of the rock were made in the laboratory of the United States Geological Survey:

	Phosphoric Acid (P_2O_5)	Equivalent in Calcium Phosphate ($Ca_3(PO_4)_2$)
Four inches from top of bed	25.86	56.45
Middle of bed	27.24	59.46
Eight inches from bottom of bed	27.40	59.81
Black phosphate	32.60	71.06
Composite sample	29.18	63.70
From lower bed	13.46	29.38

The whole area over which the phosphate beds occur or are to be expected, has not been examined, and it is not known, therefore, how much the materials vary in character and composition. Judging from what is already known it seems reasonable to suppose that better deposits than any thus far found may yet be discovered. "The point, however, to which we would direct especial attention," says Doctor Branner, "is that all of these rocks, even those running high in iron and aluminia, may be used directly as fertilizers. This is a fact of the first importance to the owners of phosphate lands and to the farmers of the South."

Mention has also been made of the occurrence of phosphate nodules in Clark County at a different geological horizon, but the pebbles have never been found in sufficient quantities to prove of economic interest.

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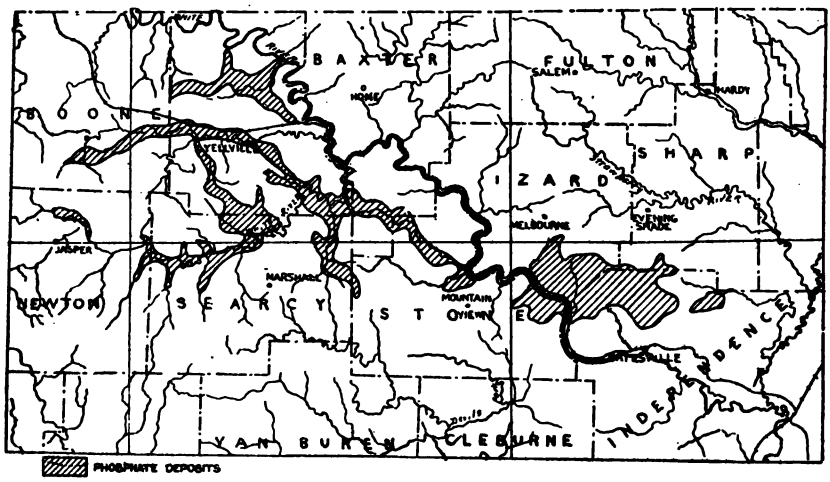

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Pinite

Hydrous alkaline silicate; Speckstein (Syn). A group well represented, but needing more study; in granitic rocks, pseudomorphous after Iolite? Also other species probably pseudomorphous after nephelite and other minerals; other members of the pinite group occur here and elsewhere; Pinite schist occurs at junction of quarts with black shale. Magnet Cove.

Potash From Leucite Rock

During the world war F. C. Calkins, of the U. S. Geol. Survey, examined the deposits of leucite rock in the Magnet Cove district of Arkansas with special reference to their possible utilization as a source of potash, but with the cessation of hostilities the European supply again became available and no development work was undertaken. The leucite rock is one of the many sources of potash which can be made use of in this country, but the difficulty of recovering the potash from this material renders it of little economic value in competition with the richer and more easily obtained potash of Germany and France on our markets.

Precious Stones

Besides diamonds, pearls and quartz crystals, which are treated under separate headings, the Arkansas list of precious stones includes amethysts, rare, but found occasionally in Montgomery and Yell counties; turquois or variscite, found in veins of quartz and in concretionary patches in dolomites in Montgomery county; garnets, in Magnet Cove; false topaz, Hot Spring County; sunstone, pink or gray, in Magnet Cove; wavelite, the latter found

also in Magnet Cove; opal, about the ancient hot springs in Saline and Hot Spring counties; jasper of various colors, in Montgomery and Polk counties; and agate, finely variegated, in Montgomery county.

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Pseudobrookite

Titanic and iron oxide. An iron bearing mineral, near brookite, is probably this. Magnet Cove.

Pyrophyllite

In serpentine and steatite; Saline County soapstone district, eastern end. Also reported by Purdue from Searcy County.

Pyroxene

Only the non-aluminous green coccolite has been distinctly recognized, but other varieties may occur.

Quartz Crystals

Quartz crystals of wonderful lustre and form are found in many parts of Arkansas, notably in the vicinity of Hot Springs, in the Crystal Mountains, which it is said has furnished some of the largest and most beautiful quartz crystals in the world. Cavities in the rocks are beautifully coated with these sparkling gems, many of them of rare color and shape; some of them with liquid cavities. They are non-mineral bearing and are valuable chiefly as curios or ornaments, being known as "Hot Springs Diamonds" because of their manufacture into trinkets and jewelry for sale as souvenirs to visitors at Arkansas' famous health resort. Clear, limpid specimens are found at Delaney in Madison County and in Crystal Mountain, near Womble, Montgomery County.

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Rectorite

A peculiar form of kaolinite, to which the name rectorite has been given, is found in Saline County. This material is tough and leathery, but it has the smooth soap feel so characteristic of the kaolins and of steatite. It occurs in association with the Carboniferous sandstones of the region, but the deposits, so far as is known, are only about a foot thick. Rectorite, as it comes from the ground, ranges in color from pure white to reddish brown. The sheets are very flexible but entirely without elasticity. It is infusible before the blow pipe, but when heated in the flame of a Bunsen burner it loses water and becomes brittle.

Road-Making Materials

The materials best adapted for road making, and having anything like a wide distribution in Arkansas, are:

A. Arenaceous shales.
B. Chert, of "flint rock."
C. Novaculite.
D. Gravels.

The arenaceous shales abound in the Lower Coal Measures of the state in the region south of the north face of the Boston Mountains, north of the Fourche and Petit Jean Mountains, and west of the St. Louis, Iron Mountain and Southern Railway. This region contains sandstones and clay shales as well as sandy shales, but as a rule the sandy shales are very widespread through it. One needs to guard against the clay shales in this region, for they are about

Road Building Scene in Arkansas.

as abundant as the sandy shales, and the two often grade into each other imperceptibly.

Chert or flint is one of the hardest of rocks, but it doesn't usually occur in considerable quantities in its original beds, but is everywhere mixed with more or less lime, so that beds of pure chert often grade into pure limestones or marbles. The cherts (in place) in this state are confined to the area lying north of the Boston Mountains and west of the Iron Mountain Railway. Not all of this area, however, contains chert beds. There are two horizons at which it occurs in large quantities—the first is that of the Boone chert and cherty limestone lying at or near the base of the Carboniferous series of rocks; the second is the great chert bed lying far below the Boone chert, geologically speaking ,and exposed in the counties through which the upper White River flows. The Boone chert (in place) begins in Independence county, just west of the Black River, and near Dota postoffice, about five miles northeast of Sulphur Rock. It forms a belt of ragged edges from five to fifteen miles wide, crossing the state from this point past Cushman, Mountain View, Marshall, St. Joe, Harrison and Eureka Springs, and forming the greater part of the surface of Benton county. Without a large map it is impossible to show the precise distribution of this Boone chert through the Northern part of the state.

Novaculite is very like chert, both in composition and in its behavior as a road-making material. It occurs, however, only in the hilly region lying south of the Coal Measures, where it forms the Zigzag Mountains about Hot Springs and the great Ouachita Mountain system south of the Ouachita River, extending from Rockport, Hot Spring County, nearly to Oklahoma, west of Dallas, Polk County. It is from this series of rocks that the famous Arkansas whetstones come. The novaculite is usually much shattered and fractured as it lies, and, being for the most part a brittle rock, it may readily be broken when it is not already small enough to be used without crushing. Like the chert, it accumulates in vast quantities in the beds of streams and in narrow valleys, and it is from these local accumulations that the materials can be had most conveniently for road-making.

Siliceous gravels have always been regarded as one of the best kinds of road-making materials. They have this considerable advantage over prepared macadam that they require no crushing, and are therefore cheaper, while they have been partially sorted by the waters which transported them to where they are found.

The material composing the Arkansas gravels is principally chert. It has been washed down the streams flowing into the Arkansas from Northwestern Arkansas and Southwestern Missouri, which fact accounts for its being found all along the Arkansas Valley. Its wide distribution across the valley is due to the meanderings and channel changes of the Arkansas River and to the ancient floods of that stream.

Beds of gravel having a similar origin occur along White and Black Rivers in North Arkansas, and follow the flood plains of those streams. Just north of Sulphur Rock, in Independence County, the water-worn materials cap the hills 250 feet above White River. Further up the river these gravel deposits occur here and there as isolated patches on the slopes of the inner curves of the large streams, often high above the present water level.

Through the eastern part of the state the gravels have a wide and even distribution in the geologic sense, though for practical purposes their distribution is local rather than general. Along Crowley's Ridge they are often found concentrated in vast quantities in the beds of streams that flow from the ridge, as for example the Little Crow Creek, near Madison, St. Francis county, where they are convenient to railway transportation and offer abundant and excellent material for road-building through the eastern part of the state, where such material is scarce, except in those favored localities along Crowley's Ridge.

About Little Rock such gravels are mingled with sands and clays that cover almost all the ground upon which the city is built. In those parts of the state lying southwest of Little Rock these gravels are of novaculite, and were derived from the region of novaculite lying between Little Rock and Dallas, in Polk County. Along what was once the old shore line upon

which they were worn, and stretching from Little Rock past Benton, Malvern, Arkadelphia, Murfreesboro, Nashville, Center Point and Lockesburg to Ultima Thule, these gravels form extensive beds, in places twenty feet or more in thickness, while to the south of this line they become gradually finer and less abundant until in the extreme southern portion of the state they occur in patches, and the individual pebbles are of small size. As in other cases, they are often concentrated along small streams and in narrow valleys. About Nashville and Center Point, in Howard County, gravels of this type are widely distributed, making good, natural roads over much of the higher ground of that and adjoining counties.

For top dressing of turnpikes or road metal any and all materials that grind up quickly under traffic, forming dust in dry weather or mud in wet weather, must be regarded as objectionable. Such materials have certain advantages for first construction in being more easily prepared, and there is therefore so much more reason for guarding against them. Materials to be avoided for such purposes are:

1. The argillaceous or clay shales.
2. Limestones.
3. Syenites or "granites."
4. Clean sandstone.

It will be seen that Arkansas is well supplied with good road materials except in the alluvial bottom lands in the eastern part of the State, and even there gravel available for such purposes may often be found in the stream beds. The road-making materials of the novaculite region and of the chert region of the north are as good as one can reasonably ask for—indeed, they are about as good as materials in their natural condition can be—while the gravels of the central and southwestern parts of the state are excellent and sufficiently abundant. In many parts of the state road-making materials are so good, so abundant, and so widespread that lack of them can never be an excuse for bad roads.

(In the lower lands of Southeastern Arkansas there are abundant supplies of gravel on the ridges between the streams of that section.—N. F. Drake.)

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Rutile

Titanic oxide. In loose crystals and in metamorphic rocks, imbedded. Abundant in float. Magnet Cove.

Sandstone

The Paleozoic area of Arkansas abounds in sandstone, most of which is undeveloped. In the large area of Pennsylvanian rocks, especially in the Boston Mountains, there is much excellent light-brown sandstone, easily quarried, and there is considerable quartzite near Hot Springs. Twenty-four sandstone quarries in eleven counties report production in this state. The largest use is for riprap, with concrete, road-making, railroad ballast and building stone following in order. * * * Sandstone quarries are operated at Carrollton, Heber Springs, Morrilton, Ozark, Hot Springs, Guion, Clarksville, Lamar, Leslie, Ft. Smith, Greenwood, Springdale, Bald Knob, Russell and Searcy.

The largest rock crushing plant in Arkansas is that operated by the Big Rock Stone and Construction Company of Little Rock, and its source of supply is the great mountain of solid rock on the north bank of the Arkansas River, opposite Little Rock, upon which rests Fort Logan H. Roots.

Sandstone Quarry at Lamar (Cabin Creek Station), Ark.

Schorlomite

Calcium-iron silicate and titanite; near Staurolite; crystals, scattered. Dr. Koenig, of Philadelphia, finds the schloromite reported from this locality to be titaniferous garnet. Magnet Cove.

Serpentine

Usually massive or in grains; in beds or masses of wide extent. Ten miles north of Benton; in imbedded patches in quartz, north of Blocher, Saline County.

Silex, Silica

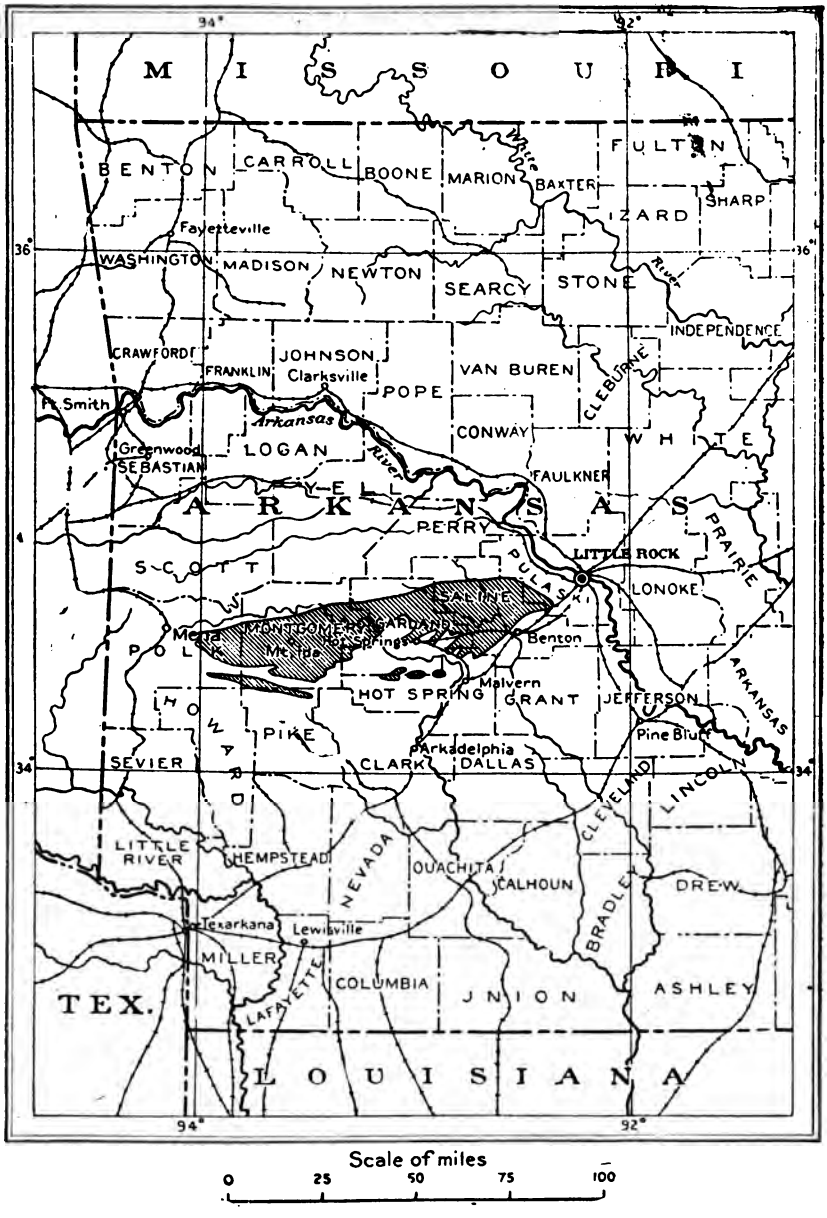
Name sometimes used as synonymous with quartz; Pealite is opal, and occurs in places where ancient hot springs made surface deposits. Magnet Cove.

Siliceous Sinter, Silica

Opal or quartz; Pealite is opal, and occurs in places where ancient hot springs made surface deposits. Magnet Cove.

Silver

There are deposits of argentiferous ores in the state, some of which are deserving of thorough examinations, although none of these have been, as yet, extensively developed. On the other hand, a considerable amount of mining work in a small way has been done in situations where there is no



Map Showing the Slate Area in Arkansas.

possible chance of success, while assays of questionable value have induced many to excavate in rocks which are even more certain to yield no silver than to prove barren in gold. * * * What is most needed in the silver areas is exploration to greater depths; in other words, development.

The mining for silver in Pulaski County has been fitful, and thus far, not profitable, but, as might be expected in the neighborhood of Little Rock, the explorations have been somewhat thorough. There are in the county three districts, the immediate environs of Little Rock, the Kellogg mining area and the region about the McRae mine. There are two districts in Saline County where prospecting has been done, but in neither of the areas have silver ores been actually mined, and there is much uncertainty concerning their occurrence. Unsuccessful prospecting also has been done in Garland and Hot Spring counties. Extensive operations have been carried on in Montgomery County, especially about Silver City, but without profit to the miners.

The silver-bearing deposits in Pike and Howard Counties are not promising. The product of the Antimony Mines (Sevier County), where they carry galena, may eventually yield the precious metal, but there is not a high percentage of it in the ore that has been mined.

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Slate

The slate area of Arkansas covers part of the Ouachita Mountains, which lie south of the Arkansas River and have a general east-west trend. The area extends from the vicinity of Little Rock about 100 miles westward nearly to Mena, and has an average width of 15 miles. The rocks include shales, slates, chert, novaculite (a deposit of extremely fine quartz grains), sandstone and a little limestone. The entire sedimentary series is estimated at 11,400 feet in thickness, of which the upper 8,825 feet contains some commercial slate.

The Missouri Mountain slate has been extensively prospected and is now quarried at Slatington. It produces both red and green slate, the former predominating. In some places the cleavage is parallel to the bedding; in others it is oblique. The slate is defective in sonorousness and in many places shows two sets of slip cleavage.

The different types of slate are described as follows: Black Slate, from Mena, near Big Fork, pure black, exceedingly fine texture and a remarkably smooth cleavage surface with a slight lustre. Dark-reddish slate, from Mena, near Big Fork, comparing favorably in texture with the "red" slate of New York. Reddish slate, from the Missiouri Mountains, not quite so red as the New York slate, but finer and softer. Greenish-gray slate from Mena, resembles the sea-green slate of Vermont. Light greenish slate from Missouri Mountain, fine texture and almost lusterless cleavage surface; probably too delicate for use as roofing. Very dark bluish-gray slate, from Sec. 25, T, 3 S, R. 29 W, fine texture and a smooth cleavage surface with a better luster; durable. Light-gray slate with a slightly greenish tinge, from Sec. 30, T. 35, R. 28 W., fine texture but lusterless, roughish surface. Very dark-gray spangled slate from quarry of S-W. Slate Mfg. Co., coarse texture and rough surface. Spangled with minute scales of mica.

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Smoky Quartz

Silicia. Variety of Quartz; in vein-like portions of beds; apparently more common in the regions where millstone grit is exposed. Magnet Cove.

Soapstone

South of Hot Springs road in the northeast quarter of Section 15, 1 N., 15 W., (12 miles northeast of Benton) there is a good showing of soapstone in favorable situation for mining. The deposit deserves to be thoroughly tested. This material was successfully used by John Olson to line the furnace doors of a lime kiln, near Alexander, more than 40 years ago. It is said to be the only deposit of soapstone west of the Mississippi river.

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Stannite

Tin Sulphide. Tin Pyrites. Suspected, in small quantity, because pyritous rock shows traces of tin; Silver World mine, Polk County.

Sulphur

In small crystals in the upper opening of the Silver Hollow mines on the east bank of Buffalo River below the mouth of Rush Creek, at the opening on the bed of iron pyrites on the Keeling place on Tomahawk Creek, and at a few other places in North Arkansas where small quantities of pyrites are exposed.

Sunstone, Pink or Gray

Cut for ornaments. Magnet Cove.

Talc Shale

This material is reported to be present along the road from Mount Ida to Black Springs, in Montgomery County. A ledge of talcose shale is also exposed in the southern half of Section 11, 1 N., 15 W., on the upper Hot Springs road in Saline County. Talcose shales and talc schists are also found in beds and pockets with black shale in Magnet Cove.

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Thuringite

In pockets and hot springs deposits; Hot Springs and northward in Garland County.

Travertine, or Tufa, Calcareous

Deposited by springs and streams, locally; impure and not abundant; in northern districts where dolomites outcrop; Yell and Garland counties, also in North Polk County.

Tripoli.

An excellent grade of tripoli has been found near Butterfield in Hot Spring county, but the extent of the deposit is unknown. This occurrence, according to H. D. Miser, United States Geological Survey, is a weathered calcareous siliceous rock, simulating the novaculites. The calcite has been leached out, leaving a pure siliceous residue of fine grain. The novaculite beds at other localities have also been altered to tripoli, notably at Caddo Gap, Montgomery County and at Langley, in Pike County.

Deposits of tripoli are reported in Montgomery, Garland, Ouachita, Washington and Independence counties.

Purdue reported that samples of good "tripoli" had been received from the vicinity of Farmington in Washington county. The quotation marks would seem to indicate that the tripoli of commerce and not pure tripoli is meant.

There is a great abundance of this material in the zinc region, but whether or not it has any commercial value is a matter that can be determined only by experiment.

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Six-Foot Vein of Tripoli, Near Delight, Ark.

Variscite

Montgomery County, translucent and transparent, emerald, bluish-green; not mined.

Vesuvianite

Yellowish green to olive green crystals; not mined. Magnet Cove.

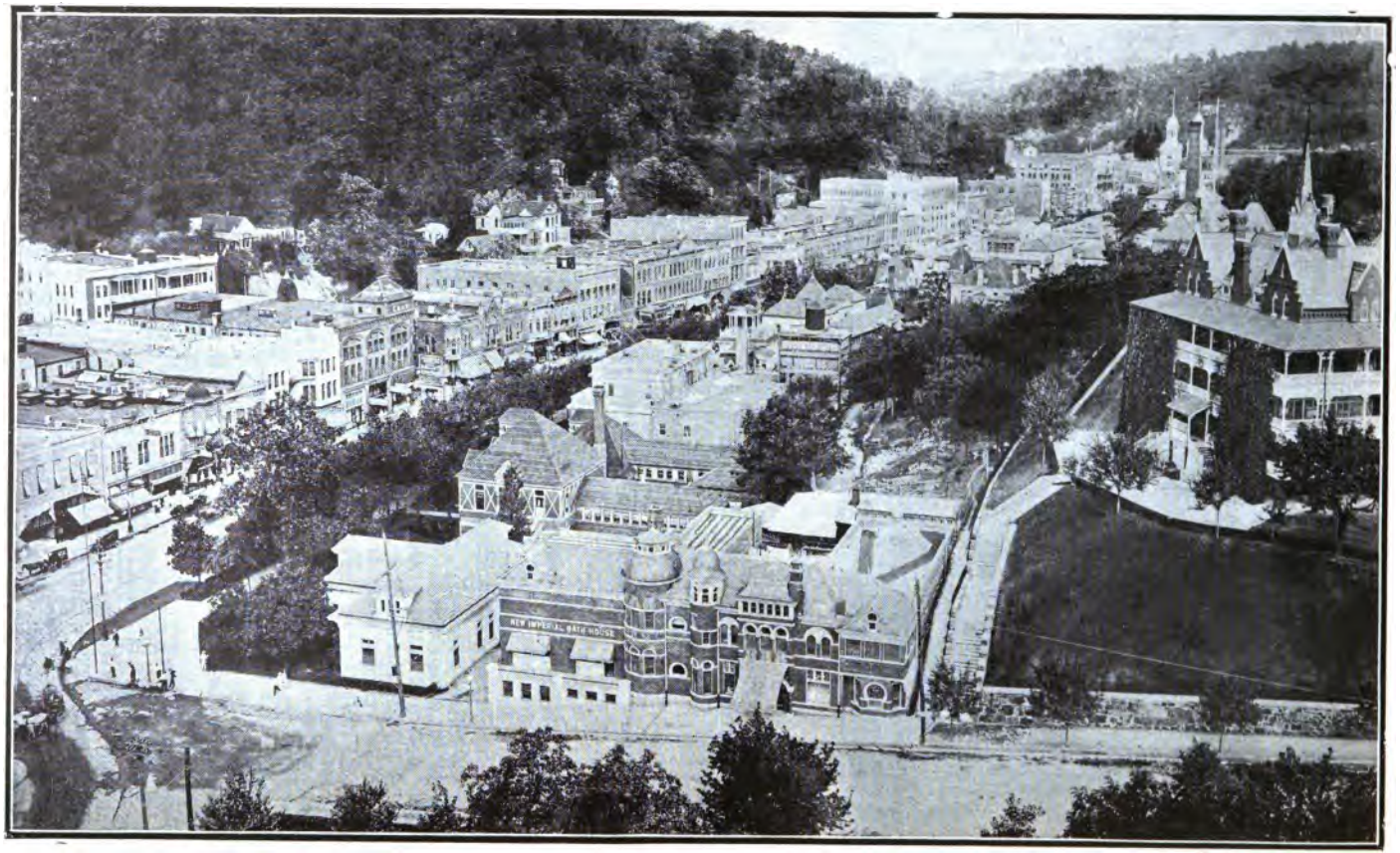
Waters

Arkansas is a well watered state. Hundreds of beautiful, free-flowing springs of excellent water gush from hillsides and valleys in all parts of the state. In the limestone region north of the Boston Mountains, such springs are especially abundant, large and beautiful. They are not mineral waters, properly speaking, but they are more valuable than if they were. Some of these springs are so big that they are utilized for driving mills, cotton gins and other machinery, and as their discharges are subject to little or no fluctuations throughout the year, they are free from the dangers of freshets and the risks of droughts. Such are Loster's Spring, six miles west, and "Big Spring," six miles northwest of Batesville; another on Mill Creek, Stone county; one at Marble City, Newton County; another on Rush Creek, Marion County, and one at Silver Spring, Benton County. At Mammoth Spring, in Fulton County, one of the finest water powers in the country is furnished by an enormous clear water spring.

Besides these truly gigantic springs, no one who travels through North Arkansas can fail to be impressed by the great number of large and beautiful springs to be found at every town and village, to say nothing of those at almost every farm house. Especially worthy of mention are the springs at Big Flat, Lone Rock, Harrison, Bellefonte, Valley Springs, Western Grove, Yardell, Marble City, Francis Postoffice (Bear Creek Springs), Berryville, Whitener and Spring Valley.

Fortunately, the Survey has made an analysis of a type of these fine springs—that of Valley Springs, Boone County. That analysis shows that water to contain only 15 grains of mineral matter to the gallon, almost all of which is carbonate of lime.

There is also an abundance of springs whose waters are remarkable for their purity; such are the Crescent Springs at Eureka Springs, Carroll



Heart of Hot Springs, Arkansas.

County, and Elixir Spring at Elixir, Boone County. These springs contain less than six grains of mineral matter to the gallon. It should be noted in regard to these two springs in particular, and the same is no doubt true of many other springs in that part of the state, that their waters pass down through the cherts, rocks that have but little easily soluble matter in them, and this is no doubt the reason of their great purity.

Running across North Arkansas from Batesville to the Oklahoma line, is a formation spoken of in the Survey's reports as the Batesville sandstone; it is the coarse, yellowish brown sandstone on which and partly of which Batesville is built. Several other towns of North Arkansas are built on this same sandstone; namely, Mountain View, Marshall, St. Joe and Green Forest. The towns mentioned get their water supply from wells dug in this Batesville sandstone; the water is soft, cool and abundant.

The Hot Springs of Arkansas

The waters of Hot Springs claim the place of first importance in any consideration of the medicinally valuable waters of the State. For a great many years these waters have been used by people from all parts of the country with results that merit the serious attention of everyone, and strike the ordinary observer as nothing short of marvelous.

There are 44 hot springs, flowing 1,000,000 gallons a day. The average temperature of the waters is 135 degrees Fahrenheit. The springs are owned and controlled by the United States and in 1832 were set apart as a National Sanitarium for all time, dedicated to the people of the United States to be forever free from sale or alienation. There are 24 bath houses connected with the springs, some of these being of palatial architecture and magnificently equipped. The operation of the baths and charges are regulated by the government through a superintendent of the reservation, appointed by the Secretary of the Interior. The government has spent large sums on the building of roads and parkways and otherwise beautifying the resort, which is visited annually by upward of 100,000 people from many parts of the world who come here for rest, recreation and treatment. Some of the world's finest resort hotels are located at Hot Springs and there are housing facilities for caring for the large number of visitors.

The waters of the hot springs are very pure. On an average the several spring water contain 12.94 grains of material in solution to the gallon. Of this material nearly 60 per cent is carbonate of lime, over 21 per cent is silica, 9 per cent is carbonate of magnesia, while the remainder is chiefly chloride of sodium (common salt), sulphate of soda (Glauber's salt) and sulphate of potash. There is but little difference in the composition of the waters of the various springs. The positive therapeutic qualities of these waters are due to physical rather than to chemical properties, their virtue being due to radio activity, which is very marked in some of the springs.

Briefly stated, the use of the Hot Springs waters opens the pores and channels for the expulsion of the matters injurious to health, arouses torpid and sluggish secretions, stimulates the circulation, the muscles, the skin, the nerves, the internal organs, and purifies the blood, removes all aches and pains, restores the exhausted, revives the debilitated and helps build up and renew the entire system. They are administered in the treatment of the sick internally and externally, being drunk in large quantities and applied in all the different forms of baths.

The cold waters of Hot Springs, Arkansas, are justly famed everywhere, both as medicinal and table waters. It is in the cold waters of Hot Springs that mineral is most evident and best results are often secured when they are drank in connection with the baths, especially in affections of kidney, bladder, stomach and rheumatic conditions. Marvelous relief in the early stages of Bright's diseases and dropsy are accredited to these waters.

Among the various cold water springs are the Desoto Springs, the Mountain Valley Springs, the Radio Magnesia Springs, the Arsenic Springs and the Potash Sulphur Springs.

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Baltwood, B. B.—"Radio-Active Properties of the Waters of Hot Springs," American Journal of Science, Vol. CLXX, Aug., 1905.

Purdue, A. H.—"The Collecting Area of the Waters of Hot Springs, Ark.", Journal of Geology, Vol. 18, 1910.

Wavellite

Hydrous aluminum phosphate. Common in radiated, spherical and hemispherical crystaline aggregations, and in similar forms thickly spread over rock surfaces, Magnet Cove.

Zinc

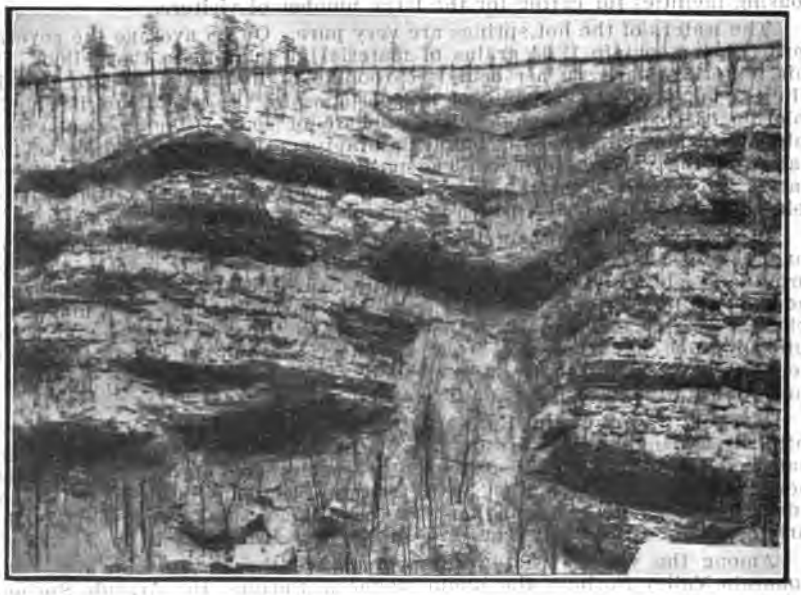
The zinc ores of North Arkansas are found for the most part in rocks of Ordovician age. The ores in the order of their importance, are sphalerite (zinc sulphide), popularly called "jack," "rosin jack," etc.; smithsonite (zinc carbonate), and calamine (zinc silicate). In addition to these, there are several minerals of zinc that are more or less abundant, but they do not occur in sufficient quantities to entitle them to be looked upon as ores. The following conclusions seem to be warranted:

The concentrates produced are generally of high grade and free from or very low in iron or lime. The sphalerite has frequently assayed 2 to 3 per cent above the price basis of 60 per cent. metallic zinc content. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite, known locally as turkey fat, which shows as high as 0.8 per cent of cadmium.

REFERENCES.

Branner, J. C.—Annual Report of the Geol. Surv. of Arkansas for 1892, Vol V. The zinc and lead region of North Arkansas, Little Rock, 1900.

Adams, Purdue and Burchard.—Zinc and lead deposits of Northern Arkansas. U. S. Geol. Surv., Professional Paper 24. Washington, 1904.



Zinc Mine, Silver Hollow Bluff on Buffalo River, Marion County.

Mounds and a Suggested Theory As To Their Origin.

By BEN F. ALLEN

The origin of mounds of from one rod to two or three rods in diameter and one to four feet high, smooth, oval, and practically round, found in flat or poorly drained places that have been or are now habitually wet, has been a mystery to which geologists have given much study. It is the writer's belief that they are caused by alkalines localizing in spots in soils thus being rendered less subject to erosions. The resistance of alkaline soils to erosion is well known, especially lime soils. Thus these spots gradually assume the form of mounds by the washing away of the surrounding soil which is rendered more susceptible to erosion as the alkalines leach out of it.

It is well known that all alkalines not only obey the laws of affinity and molecular attraction but have a strong tendency to creep up and out of any solution and to reach free air, where they crystalize. If present in sufficient strength in their struggle with the acids, an uprooted tree or a gopher mound or other bit of soil protruding above the wet surface is a convenient place for the alkalines to congregate and escape to the air and crystalize, and a nucleus for a mound is started. The mounds are formed only in places that are or have been wet enough during a good part of the year and flat enough to facilitate free lateral molecular circulation of soluble elements.

These mounds are not found in lime or other strongly alkaline soils, nor are they found in soils strongly acid and extremely weak in alkalines, because a sufficient variation in solution cannot be produced to cause a sufficient difference in erosional susceptability. Following this, if a soil where mounds are now plentiful should become either strongly acid or strongly lime the mounds would disappear. In places they are disappearing, owing to the influence of levees, drainage, or irrigation or flooding by hard or soft water. If the wetness or stillness or stagnation of the soil solution is corrected by good drainage they will disappear. But in some places they are growing, or, the surrounding soil is being washed away, leaving the mounds more prominent, even in pastures where the tramping of cattle and other stock would ordinarily be expected to cause the soil to wash away. They consist of the same soil as that surrounding them of the same geological level, and contain the same strata, gravel and even stones. Their internal decomposition is altered perhaps by the slight differences in the water solution. They are not accretions, but just the opposite—they are residuary. They are soft and mealy on top, for they are better drained and more alkaline than elsewhere. The facts can easily be demonstrated by the spade and by litmus tests. These mounds thus become of little interest to the geologist prospecting for oil or mineral, but they become of very material interest to the farmer.

Magnet Cove.

Magnet Cove, Hot Spring County, has long been known as a locality for many rare and beautiful as well as useful minerals and there is hardly a cabinet of minerals in the world that does not contain numerous specimens from this renowned district. This small area is of great interest not only to the mineralogists, but to the petrographer both on account of the number of varieties of rocks found there and of the many instances in which the association of the rocks is such that an insight into their genetic relations may be obtained.

The magnetite of Magnet Cove is in the form of lodestone and will attract pieces of iron as does an ordinary magnet.

REFERENCES.

Annual Report Arkansas Geological Survey, Vol. II., 1890, Igneous Rocks, by J. Francis Williams.

Interior Diamond Cave, Newton County.

Diamond Cave of Newton County

Near Jasper, Newton County, Arkansas, is Diamond Cave, a subterranean wonder place rivaling in grandeur and excelling in beauty the famous Mammoth Cave of Kentucky. The Arkansas cavern has been explored for a distance of 20 miles from the entrance, it is claimed, and a route for tourists covers some eight miles of sight-seeing through forests of stalagmites and under festoons of gorgeous stalactites, the display of calcite crystals being wonderfully brilliant and fairy-like in the delicacy of their formations. The existence of the cave has been known for many years but until the recent completion of an automobile road to Jasper, from Russellville and Harrison, it was difficult for tourists to reach the cave, the mouth of which is about four miles from Jasper.

Other Publications of the State Bureau of Mines, Manufacturers and Agriculture

Industrial Guide, a Directory of Manufactures.
Large Township, Railroad and Resources Map of Arkansas.
Arkansas Information, for Homeseekers and Investors.
Arkansas Farm and Marketing Bulletin, Monthly.
Pleasure Resorts in Arkansas, for the Tourist.

Sent Free on Request.
JIM G. FERGUSON, Commissioner,
Little Rock, Ark., U. S. A.

Federal and State Laws on Minerals and Mining

Synopsis of United States Mining Laws.

A bulletin may be obtained from the Department of Interior, Washington, D. C., or the United States Land Office at Little Rock, Camden or Harrison, Ark., giving complete instructions concerning the filing of mining claims on government land.

(Chapter VI, Revised Statutes.)

Section 2318. Lands valuable for minerals shall be reserved from sale, except as otherwise expressly directed by law.

Section 2319. All valuable mineral deposits belonging to the United States are declared to be free and open to exploration and purchase, by citiens of the United States and those who have declared their intention to become such under regulations prescribed by law, and according to the local customs or rules of miners in the several mining districts, so far as the same are applicable and not inconsistent with the laws of the United States.

Section 2320. A mining claim, whether located by one or more persons, may equal, but shall not exceed 1,500 feet in length along the vein or lode; but no location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located. No claim shall extend more than 300 feet on each side of the middle of the vein at the surface, nor shall any claim be limited by any mining regulation to less than 25 feet on each side of the middle of the vein at the surface. The end lines of such claims shall be parallel to each other.

Section 2321. Proof of citienship required.

Section 2322. Locators have the exclusive right of possession and enjoyment of all the surface included within the lines of their locations, and of all veins, lodes and ledges throughout their entire depth, the top or apex of which lies inside of such surface lines extending downward vertically, although such veins, lodes or ledges may so far depart from a perpendicular in their course downward as to extend outside the vertical side lines of such surface location. But their right of possesion to such outside parts of such veins or ledges shall be confined to such portions thereof as lie between vertical planes drawn downward as above described, through the end lines of their locations, so continued in their own direction that such planes will intersect such exterior parts of such veins or ledges. And nothing in this section shall authorize the locator or possessor of a vein or lode which extends in its downward course beyond the vertical lines of his claim to enter upon the surface of a claim owned or possessed by another.

Section 2323. Where a tunnel is run for the development of a vein or lode the owner shall have the right of possession of all veins or lodes within 3,000 feet from the face of such tunnel on the line thereof, to the same extent as if discovered from the surface.

Section 2324. Miners of each mining district may make regulations not in conflict with the State or Federal laws, governing the location, manner of recording, amount of work necessary to hold possession of a mining claim, subject to the following requirements:

The location must be distinctly marked on the ground so that its boundaries can be readily traced.

All records of mining claims shall contain the names of the locators, date of location and description of the claims by reference to some natural object or permanent monument as will identify the claim.

On each claim not less than $100 worth of labor shall be performed or improvements made during each year. Upon a failure to comply with these conditions the claim or mine shall be open to relocation.

Section 2325. Patents are obtained by filing in the proper land office

an application, under oath, showing compliance with all regulations, together with a plat and field notes of the claim, and claimant shall post a copy of such plat and notice of such application in a conspicuous place on the land, and shall file an affadavit of at least two persons that such notice has been duly posted and shall file a copy of the notice in such land office, and shall thereupon be entitled to a patent for the land.

The register of the land office, upon the filing of such application, plat, field notes, notices and affadavits, shall publish a notice that such application has been made, for 60 days in a newspaper published nearest to such claim; and post such notice in his office for the same period.

The claimant within the sixty days of publication shall file with the register a certificate of the United States surveyor-general that $500 worth of labor has been expended or improvements made upon the claim and that the plat is correct. At the expiration of the sixty days the claimant shall file his affidavit, showing that the plat and notice have been posted in a conspicuous place on the claim during the period of publication.

If no adverse claim shall have been filed at the expiration of sixty days it shall be assumed that the applicant is entitled to a patent upon the payment to the proper officer of $5 per acre.

Section 2326. How adverse claims may be filed.
Section 2327. Description of mining vein or lode claims.
Section 2328. Pending applications; existing rights.
Section 2329. Conformity of placer claims to surveys; limit of.
Section 2330. Subdivisions of 10-acre tracts; maximum of placer locations.
Section 2331. Conformity of placer claims to surveys, limitation of claims.
Section 2332. Evidence of possession necessary to establish a right to a patent.
Section 2333. Proceedings for patent for placer claim.
Section 2334. Surveyor-general to appoint surveyors of mining claims.
Section 2335. Verification of affadavits.
Section 2336. Where two or more veins intersect or cross each other, priority of title shall govern, but the subsequent location shall have the right-of-way through the space of intersection for the purpose of the convenient working of the mine.
Section 2337. Patents for non-mineral lands.
Section 2338. Local legislature of any State may provide rules for working mines.
Section 2339. Vested rights to use of water for mining; right of way for canals.
Section 2340. Patents, pre-emptions and homesteads subjected to vested and accrued water rights.
Section 2341. Mineral lands, upon which no valuable mines have been discovered, may be homesteaded in quantities not to exceed 160 acres, or purchased for agricultural purposes at $1.25 an acre.
Section 2342. How mineral lands may be set apart as agricultural lands.
Section 2343. President authorized to establish additional land districts.

Sections 2344-2346. Provisions of this chapter not to affect certain rights. Mineral lands in certain states excepted. Grant of lands to States or corporations not to include mineral lands.

FEES OF REGISTERS AND RECEIVERS.

The fees payable to the register and receiver for filing and acting upon application for mineral land patents are $5 to each officer, to be paid by the applicant for patent at the time of filing, and the like sum of $5 is payable to each officer by an adverse claimant at the time of filing his adverse claim.

MINERAL LANDS WITHIN NATIONAL FORESTS

Mineral lands in the National Forest Reserves are subject to location and entry under the general mining laws in the usual manner.

COAL MINING LEASES

(Public—No. 146—66th Congress.)

The secretary of the interior is authorized to divide any of the coal lands, owned by the United States in Arkansas, into leasing tracts of 40 acres each, or multiples thereof, and in such form as will permit the most economical mining of coal, but in no case exceeding 2,560 acres in any one leasing tract, and shall award leases thereon by competitive bidding or by such other methods as he may by general regulations adopt, to any qualified applicant.

Permits may be obtained for prospecting or exploratory work necessary to determine the existence or workability of coal deposits and if the land contains coal in commercial quantities the permittee shall be entitled to a lease for all or part of the land in his permit.

Railroads are not permitted to lease any coal deposit except for their own use.

Lessees shall pay to the United States a royalty of not less than five cents per ton and an annual rental of 25 cents per acre for the first year; 50 cents per acre for the second, third, fourth and fifth year, respectively, and not less than $1 per acre for each and every year thereafter, except that such rental for any year shall be credited against the royalties as they accrue for that year.

The Secretary of the Interior may issue permits to individuals or associations to prospect for, mine and take for their use but not for sale, coal from the public lands without payment of royalty, in order to provide for the supply of strictly local domestic needs for fuel; this privilege shall not extend to any corporation other than municipalities.

The provisions of this act shall also apply to all deposits of coal, phosphate, soduim, oil, oil shale or gas.

For past production 20 per centum and for future production, 37½ per centum of the amounts derived from such royalties and rentals shall be paid to the State wherein the leased lands or deposits are located, said moneys to be used by such State for the construction and maintenance of public roads or for the support of public schools or other public educational institutions as the legislature of the State may direct.

Royalties accruing under any oil or gas lease on demand of the Secretary of the Interior shall be paid in oil or gas.

OIL SHALE LEASES.

(Public—No. 146—66th Congress.)

The Secretary of the Interior is authorized to lease any deposits of oil shale belonging to the United States and the surface of so much of the public lands containing such deposits or land adjacent thereto, as may be required for the extraction and reduction of the leased minerals; no lease shall exceed 5120 acres of land; for the privilege of mining, extracting and disposing of the oil or other minerals covered by a lease under this section. The lessees shall pay to the United States 50 cents per acre per annum for the lands included in the lease and such royalties as shall be specified in the lease, the rental paid for any one year to be credited against the royalties accruing for that year; to encourage the production of petroleum products from shales the Secretary may, in his discretion, waive the payment of any royalty and rental during the first five years of any lease; not more than one lease shall be granted to any one person, association or corporation.

State Law On Recording of Government Mining Claims

(Digest of the Statutes of Arkansas, 1921)

Section 7326. **Notice to be recorded.** In every county in this State in which lands containing mineral still belong to the United States government, the recording of mining claim notices of all kinds may be done with the ex-officio recorders of the various counties in which said lands are situated.

Section 7327. **Fees.** The fees for recording mining location notices shall be one dollar for notice, to be paid in United States currency, one-half of which shall go into the County treasury to the credit of the record fund. The fees for recording all other mining notices shall be the same as are now allowed by law for recording deeds.

Section 7328. **Record book.** The recorder shall procure a suitably bound book and shall make a plat therein of each mining claim located for the free use of all miners who may wish to examine the same.

Section 7329. **Establishment of claim; limitation.** When any owner or claimant of any mining claim on any of the lands subject to location as mining claims in this State under the laws of the United States shall have had possession of such claim for a period of three years and shall have performed the necessary amount of annual labor or improvement to hold said claim, as now required by law for said period, the same shall be sufficient to establish his possessory right to the same; provided, that if said claimant shall have performed the necessary work for any one year during said period and shall have resumed work at any time before the right of others intervene, then he shall be entitled to the possessory right to the same. No person shall maintain an action against such claimant for the recovery of a mining claim, unless the same shall be commenced within one year after his right of action shall accrue.

Section 7330. **Affidavit of assessment work.** On or before the thirty-first day of December of any year in which the time expires in which the assessment work or improvement now required by law to hold the same, the owner of such claim or in his absence his agent or the party who was in charge of the work for the claimant, may make and file for record in the recorder's office in the county in which said claim is situated, an affidavit in substance as follows:

STATE OF ARKANSAS
County of .....

....., being duly sworn, deposes and says that at least $..... worth of work or improvements were performed or made upon (here describe claim) situated in.....mining district, county of.....and State of Arkansas, between the .....day of.....and the.....day of.....A. D., and that such expenditure was made by or at the expense of..... owners of said claim for the purpose of complying with the law.

Signature.....

Jurat.....

And said affidavit, when so filed and recorded, shall be prima facie evidence of the performance of such labor or the making of such improvements.

Section 7331. **Indexed record.** Hereafter it shall be the duty of the recorder of any county in which mining location notices and proof of labor performed shall be recorded, to keep a suitably bound plat book properly arranged, showing all the legal subdivisions affected by such notices, in which he shall keep a complete index of all such instruments recorded, showing the number of the book and page on which they are recorded, and this index shall be kept up to date of recording.

Section 7332. **Penalty.** Any recorder who shall neglect, refuse or fail to keep such index as above provided for shall be guilty of a misdemeanor, and upon conviction shall be fined in any sum not less than $25 nor more than $100.

The State has no supervision over Government lands. For plats and information apply to the U. S. Land Office, Little Rock, Camden, or Harrison, Ark.

Law Creating Arkansas Bureau of Mines, Manufactures and Agriculture.

(Digest of Statutes of Arkansas, 1921)

Section 7333. **Department created.** A department is constituted and established, which shall be known and designated as the "Arkansas Bureau of Mines, Manufactures and Agriculture," and shall be superintended by a Commissioner to be appointed by the Governor, as hereinafter prescribed.

Section 7334. **Appointment—election—salary—reports.** The Governor shall appoint, by and with the advice and consent of the Senate, some suitable and competent person Commissioner of Mines, Manufactures and Agriculture, who shall be elected as other State officers every two years thereafter, and he shall be paid for his services the sum of eighteen hundred dollars per annum; said commissioner shall take the oath of office prescribed for other State officers, and shall give bond in the sum of ten thousand dollars for the faithful performance of his official duties, which bond shall be examined and approved by the Governor, and he shall make a biennial report to the Governor of the things pertaining to his office, and also giving an itemized statement of the disbursement of all moneys appropriated and used for the benefit of said bureau.

Section 7335. **Powers and duties of Commissioner.** The Commissioner of Mines, Manufactures and Agriculture shall conduct the Bureau of Mines, Manufactures and Agriculture at the seat of government of this State, in the Capitol building. He shall have control of all books, papers, documents and other property which may belong to or be deposited in said bureau including specimens of minerals, vegetable and animal products of the State; keep a record of all State and county agricultural societies, keep and file all reports which may be made from time to time by such societies, and all correspondence of the bureau from other persons or societies appertaining to the general business of husbandry, mining and manufacturing; address circulars to societies and good practical farmers in various parts of the State and elsewhere, with a view of eliciting information upon the latest and best mode of culture of those products, field crops, fruits, ,vegetables, etc.,, adapted to the soil and climate of this State; also on all subjects connected with field culture, horticulture, stock raising and dairying. He shall also encourage the formation of agricultural and horticultural societies throughout the State and purchase, receive and distribute such rare and valuable seeds, plants, etc., as it may be in his power to obtain from the general government and other sources, as may be adapted to the soils and climate of this State. He shall also encourage the importation of improved breeds of horses, cattle, sheep, hogs and other live stock, and the introduction of labor-saving implements of husbandry, and diffuse information in relation to the same. He shall encourage such domestic industry and household arts as are calculated to promote the general thrift, welfare and resources of the State. To effect these objects, he shall correspond with the Department of Agriculture at Washington and representatives of our national government abroad, and if possible procure valuable contributions of seeds, plants, etc., from the same.

Section 7336. **Further duties.** The seeds, plants, etc., received by the Commissioner of Mines, Manufactures and Agriculture shall, so far as practicable, be distributed throughout the State, and placed in the hands of farmers and others who will agree to cultivate them properly and return to the commissioner a reasonable portion of the products thereof, with a statement of the mode of cultivation and such other information as may be necessary to ascertain their value for general cultivation in this State. Information in regard to agriculture may be published by him from time to time in the newspapers of the State, provided it can be done without expense to the State. He shall cause an analysis to be made of all commercial fertilizers manufactured in or imported into the State, so as to find the true value thereof, and shall publish the result of such analysis for the general information of the citizens of this State. The chemical department of the University shall, as far as practicable, make such analysis.

Section 7337. **Mining and mineral lands—information as to.** The Commissioner of Mines, Manufactures and Agriculture shall keep a record of all individuals, companies and incorporated companies engaged in mining and manufacturing in this State, and shall address circulars to all such individuals, companies and incorporated companies engaged in mining of coal, manganese, silver, lead, copper, or any other minerals, and to all persons quarrying marble, granite or any other variety of stone in this State, with view of eliciting as to the extent of deposit, output, cost of production and facilities for transportation. He shall also address circulars to persons owning mineral lands upon which no mining is being prosecuted, so as to obtain information as to the locality, character of mineral, extent of deposit, facilities for working and transportation, and all other information in regard to the same that may be necessary to arrive at a correct conclusion as to value.

Section 7338. **Statistics—distribution of pamphlets.** The Commissioner shall methodically arrange all of the statistics in relation to the agricultural, manufacturing and mineral resources of the State, collected by him as hereinbefore provided, and which, in his opinion, would furnish useful information to persons who may wish to immigrate into this State, or to persons seeking to invest capital, and shall lay the same before the Governor; and if in his opinion such statistics contain information in regard to the resources of the State calculated to induce immigration and investment of capital, he shall cause the same to be printed in pamphlet or circular form, or in both, and as many copies as he may deem necessary; when printed, the Commissioner shall distribute the same in such manner as he may think most advantageous to induce immigration and capital into this State.

Section 7339. **Deputy commissioner—appointment—salary.** The Commissioner of Mines, Manufactures and Agriculture shall be allowed one clerk, who shall be deputy commissioner, to assist him in conducting the business of said bureau, to be appointed by said Commissioner, in writing; said deputy shall take the oath of office prescribed by law, which shall be indorsed on the appointment and filed in the office of the Secretary of State. The Commissioner shall be responsible for all acts done or performed by his deputy in the performance of his official duties, and said deputy shall receive the sum of two hundred dollars per month for his salary.

Section 7340. **Collection and arrangements of specimens.** The Commissioner shall procure from the person having charge of the specimens of the vegetable, mineral and manufactured products of the State, exhibited at New Orleans at the World's Industrial and American Exposition, and place the same in a suitable room in the State Capitol building, or in some suitable room contiguous thereto, and he shall arrange said specimens in said room in such manner that they can be seen and examined to the best advantage, and shall place on each specimen a label indicating the particular locality where the same was found or produced. It shall be the duty of the commissioner from time to time to add to said collection by procuring specimens of all valuable minerals found in this State, and all the vegetable products grown or found therein; articles of a perishable nature shall be so prepared as to secure their preservation as much as possible. It shall be the duty of the Commissioner in collecting specimens to procure information as to the locality where found, quantity, extent of deposit, facilities for working, transportation and all other facts of importance in connection therewith; and in case of vegetable products, so far as practicable, obtain all information as to locality, character of soil, climate, etc.; and shall attach to each specimen a label showing where found or produced, and numbered, and shall enter, in a book, kept for that purpose, a brief synopsis of the information obtained in regard to each specimen; said entries to be so numbered and indexed as to afford easy reference.

Section 7341. **Traveling expenses.** Whenever, in the opinion of the Commissioner, it is necessary to visit any locality in this State for the

purpose of procuring correct information in regard to any fact connected with the mining, manufacturing or agricultural resources of the State, he shall, with the approval of the Governor, visit such locality, provided not more than three hundred dollars per annum shall be allowed said Commissioner for such traveling expenses.

Section 7342. **Vacancies.** The Governor shall fill any vacancy occurring in the office of Commissioner by appointment. Act March 7, 1889.

Geological Commission

(Digest of the Statutes of Arkansas, 1921)

Section 4972. **Commission Created—State Geologist.** A commission is hereby created, consisting of the Governor of the State, who shall be ex-officio chairman of the commission, the President of the University of Arkansas, and the Commissioner of Mines, Manufactures and Agriculture, to be known as the Geological Commission of Arkansas; said commission shall serve without compensation from the State, but shall be reimbursed for actual expenses incurred in the discharge of their duties; and the Governor of the State is hereby authorized to appoint the professor of geology in the University of Arkansas as ex-officio State Geologist.

Section 4973. **Duties of Commission.** It shall be the duty of said commission to direct the State Geologist, in co-operation with the U. S. Geological Survey, to investigate, or to have investigated, such of the natural resources of the State, consisting of the available water power of the streams, the clays of the State as related to their adaptability to the various purposes for which clays are utilized, the cement materials of the State, the road materials of the State, and such other minerals and economic geologic products, as it may be deemed practicable and advisable by said commission to have investigated, and to prepare or have prepared such topographic maps as may be deemed advisable; that said commission may direct said State Geologist to make or have made such investigations as may be deemed advisable relating to the conservation of such natural resources as are exhaustable; that said commission may direct said State Geologist, in co-operation with the U. S. Geological Survey, to make such investigations as may be deemed advisable relating to the safety of miners and mine operations and to adopt such measures as may be deemed practicable to assist mine operators in preventing explosions and give relief in case explosions occur.

Section 4974. **Duty of the State Geologist.** It shall be the duty of said State Geologist to make such reports to said commission as are necessary to a complete understanding of the results obtained from such investigations as shall be undertaken, and to perform such other duties as usually belong to the office of State Geologist; the reports (shall) be accompanied by such maps, sections and other illustrations as are necessary to their complete understanding; the cost of publishing said reports shall be paid out of money appropriated for public printing; the number of copies of each report shall be 4,000; the members of the General Assembly, the Geological Commission, and the State Geologist shall each have twenty copies; that one copy be sent to each of the State Universities of the country; that one hundred copies be sent to the Department of Geology, University of Arkansas, for exchange with other State Geological Surveys; and that the remainder be distributed by the State Geologist, without charge, upon application and receipt of the necessary postage or expressage.

Section 4975. **Assistants.** It shall be the duty of said State Geologist, by and with the approval of said commission, to appoint such trained geological assistants, engineers and others efficient in the arts and sciences, as may be necessary to completely carry on the investigations undertaken; that the said State Geologist, assistants and engineers, are hereby directed to go into any mine or other place where it is thought necessary by the said State Geologist to go, in executing the directions of said commission; that all salaries shall be determined by said commission, and shall be per diem and only for the time of actual service.

Section 4976. **Co-operative arrangements.** The Geological Commission of Arkansas is authorized to enter into such co-operative arrangements with the United States Geological Survey, or other Federal bureaus, for carrying on the work of the Geological Survey of Arkansas, as may be advantageous to the State.

Section 4977. **Expenses.** The State of Arkansas shall pay such portions of the expenses (field and traveling expenses including salaries) as may be agreed upon between said commission and the United States Geological Survey; the full and complete results of said surveys shall be available for publication in State reports; and the expense of the office work for the State reports shall be borne by the State.

Section 4978. **Moneys, how expended.** All moneys shall be expended under the direction of the commission, upon the certificate of the State Geologist and the approval of the Governor, which certificate and approval shall alone authorize the Auditor of State to draw his warrant upon the treasurer for the amount certified and approved. Provided that in no event shall said commission expend a sum exceeding the amount appropriated.

Sand, Gravel, Oil and Coal Taken From River Beds.

(Digest of the Statutes of Arkansas, 1921)

Section 6789. Hereafter it shall be unlawful for any person, firm, corporation or association of persons to take sand or gravel, oil and coal from the beds or bars of navigable rivers and lakes of this State without first procuring the consent of the Attorney General of the State. Such consent may be withheld unless such person, firm, company or corporation shall agree in writing to keep an accurate record and account of all sand and gravel, oil and coal taken by him or them from said rivers and lakes, and render to the said Attorney General at the end of each month an itemized, verified statement of all the numbers of cubic yards of sand and gravel, and gallons of oil and tons of coal taken out each day during the month. At the time of making such statement the person, firm, company or corporation shall pay into the State Treasury two and one-half cents for each cubic yard of sand and gravel so taken, and one-half cent for each gallon oil and six cents per ton for coal taken, and if any other valuable minerals are found in such rivers, any firm, corporation or persons taking the same out shall make a contract with the Attorney General, stating the per cent due the State.

Section 6790. Provides penalty of not less than $300 and not more than $1,000 for non-compliance with above and empowers Attorney General to bring suit to recover royalties for State.

Section 6791. Applies to commercial users only, no charge to be made to those who remove sand or gravel, oil and coal for their own personal or private use.

Section 6792. Funds collected go to general revenue fund.

Section 6793. Any firm, corporation or person may take and remove gravel and sand from the bed or bars of any navigable river or lake within the State of Arkansas, when the same are used for road building, without paying the State of Arkansas any amount whatever for the same, but they shall keep an account of such removals (Section 6794) and file same with the Attorney General and a copy with the county judge where such sand and gravel is taken. If such account is not kept and proper reports made (Section 6795) parties removing sand and gravel shall be required to pay for same.

Water Power.

(Digest of the Statutes of Arkansas, 1921)

Section 10458. **Belongs to State.** All water power in this State situated for the purpose of producing power for all lawful purposes, is and the same is hereby declared to be inherent in, and a part of the public

domain, and shall vest in and be for the use of the State of Arkansas, and the people thereof, for its and their use and benefit.

Section 10459. **Right to Erect Dams.** Any person or corporation organized under the laws of this State, for the purpose of producing power for any lawful purpose, and who or which owns a natural, practical damsite, or who or which has secured from the United States license, permit or authority to erect a dam upon land on a damsite owned by the United States, and who or which has procured a charter from this State for the development and operation of electric power plants from said water powers, shall have the right to erect a dam across any navigable or non-navigable river in this State at such point, for the purpose of developing such electric power.

Section 10460. **Survey and Estimate Expense.** When said person or company is ready to begin the construction of his or its dam, it shall file with the Secretary of State and with the County Clerk of the county or counties in which the lands pertaining to such water power are situated, a survey showing the location of his or its principal power damsite, of the stream above such power damsite and the lands necessary for the development of such water power, with an estimate and the engineer's report of the cost of his or its dam, spillways, power plant and all machinery to be used in generating such power, to be verified later by report of actual cost of construction.

Section 10461. **Permit from Corporation Commission.** When said person or corporation is ready to proceed with the construction of his or its dam, he or it shall present to the Corporation Commission of Arkansas his or its application for a permit to use such power, and upon a hearing of such application the said board may grant to such person or corporation a permit to erect such dam or dams, and use such power, and shall fix a minimum and maximum compensation per horsepower to be received by such corporation for the use of the power so generated. Provided, however, any person or corporation owning or controlling any dam, as herein provided, is required to construct and keep open a chute over such dam or construction sufficient for the passage of fish, either ascending or descending such river or water course.

Section 10462. **Sale of power.** Such power shall be for public use, and shall be sold to private parties desiring it in the order of their application, and upon equal terms; and such power shall be furnished by such person or corporation at his or its principal powerhouse or central station. Such power may be applied directly by water or through the instrumentality of electricity or such other agencies as such person or corporation may elect.

Section 10463. **Assessment of tax.** If any person or corporation taking or using such power shall elect to use said power exclusively for its own use in manufacturing or other purposes named in this act, the Corporation Commission of Arkansas shall assess the tax for taking and using such power on the basis of power so taken and used, said power to be charged for as if it had been sold to private consumers.

Section 10464. **Damages for Injury to land.** In case any person or corporation building any dam shall not agree with the owners of any lands used for the purpose of the dam are flooded thereby, the court shall assess the damages for the land flooded or taken, and also the consequential damages to any lands necessary to the use of the lands taken or flooded and owned by the parties whose lands are taken and flooded.

Section 10465. **Tax on gross revenue.** The Corporation Commission of Arkansas shall grant to any person or corporation the right to take and use such power described in this act under the following terms and conditions: Every person or corporation taking and using said power shall pay into the treasury of the State of Arkansas for the benefit and use of the general revenue fund one-fourth of one per cent of its annual gross revenue as determined by the power generated and sold for a period of ten years from the time it shall begin operation, and one-half of one per cent of its annual gross revenue thereafter.

Section 10466. **Right of eminent domain.** In order to enable such corporation to carry out the purposes of this act, the State's power of eminent domain is hereby conferred upon it, in so far as it is necessary to enable it to condemn land overflowed above its dam, and to condemn lands for right-of-way for viaducts, and for electric transmission of power generated to points of its utilization. In all cases where such corporation fails to obtain by agreement with the owner or owners of the property, the right to overflow such land or lands, or the right-of-way for viaducts and electric transmission lines, it may apply to the circuit court in the county or counties in which the property is situated, by petition, to have the damages for such overflowed land or lands or right-of-way assessed, giving the owner or owners of such property at least ten days notice in writing of the time and place where such petition will be heard.

Section 10467. **Notice to non-resident owners.** If the owner or owners of said property be nonresidents of the State, such notice shall be given by publication, as provided in civil cases.

Section 10468. **Guardians of minors, etc.** In case proceedings are had against infants, or persons of unsound mind, it shall be the duty of the court to appoint a guardian ad litem, who shall represent their interests for all purposes.

Section 10469. **Petition—description of land.** Such petition shall, as nearly as may be, describe the lands to be overflowed or taken for right-of-way for viaducts and electric transmission lines, and shall be sworn to.

Section 10470. **Jury.** It shall be the duty of the court to empanel a jury of twelve men, as in other civil cases, to ascertain the amount of compensation which said corporation shall pay, and the matter shall proceed and be determined as other civil cases.

Section 10471. **Payment of damages.** In all cases where damages have been assessed it shall be the duty of the corporation to deposit with the clerk of the court, or to pay to the owners the amount so assessed, and to pay such costs as may be adjudged against it, within thirty days after such assessment whereupon it shall be lawful for the said corporation to enter upon said lands and proceed with the work of developing such water power.

Section 10472. **Deposit to cover damages.** When the determination of questions in controversy in such proceedings is likely to retard the progress of the work, the court, or judge in vacation, shall designate an amount of money to be deposited by said corporation, subject to the order of the court, and for the purpose of making said compensation when the amount thereof shall have been assessed, as aforesaid, and said judge shall designate the place of said deposit. Whenever such deposit shall be made, it shall be lawful for the corporation to enter upon such lands and to proceed with its work prior to the assessment and payment of damages for the use thereof.

Section 10473. **Forfeiture for failure to make deposit.** In all cases where such corporation shall fail to pay or deposit the amount of damages assessed as aforesaid within thirty days after such demand, it shall forfeit all rights in the premises.

Section 10474. **Commencement and completion of the work.** All charters and permits granted under this act shall be void unless construction shall be begun within two years from the date of the permit, and shall be completed within four years from the date of permit.

Co-Operative Soil Survey

(Act 542, General Assembly, 1921)

An Act to provide for co-operative soil survey work between the Federal Bureau of Soils and the Arkansas State Experiment Station and for other purposes.

Whereas, the Federal Government makes an annual appropriation to the Bureau of Soils of the United States Department of Agriculture for Soil Survey work, and

Whereas, said Bureau has offered and agreed to co-operate with the State of Arkansas through the State Experiment Station in such work and to furnish and pay expenses of men to do such work provided the State can furnish an equal number of men to take care of the expenses of soil analysis and other incidental expenses, and,

Whereas, a thorough scientific soil survey is the basis for further investigation of soil need, maintenance of fertility, and methods of handling soils and growing crops, therefore,

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF ARKANSAS:

Section 1. That the Director of the State Experiment Station of the College of Agriculture, University of Arkansas, is hereby authorized to expend such sums as are hereinafter provided and necessary for the purpose of conducting a scientific investigation of the soils of the counties of the State of Arkansas, classifying and locating the different soils. surveying and mapping such soils, describing, analyzing and examining the same and otherwise locating the various types and kinds of soil in the counties of this State and ascertaining their constituent elements of plant food, their plant food deficiencies and any other information regarding the said soils which will be helpful to the agricultural interests of the State and printing, publishing, and distributing reports and soil maps of the areas surveyed and such work may be conducted in co-operation with the Bureau of Soils of the United States Department of Agriculture and with the several counties of the State of Arkansas.

Section 2. The Director of the State Experiment Station is hereby authorized to employ competent assistants and soil survey men to make such surveys, to fix their compensation, to purchase necessary supplies and equipment, to pay travel and such other expenses as may be necessary to carry out the provisions of this Act, including cost of printing, publishing and distributing report of such soil surveys.

Section 3. The county courts and tax levying boards are hereby authorized and empowered to make appropriations out of the general revenue fund of the county for the purpose of co-operating with the State Experiment Station in carrying out the provisions of this Act.

Section 4. That there is hereby appropriated out of any money in the General Revenue Fund in the State Treasury the sum of Seven Thousand Five Hundred ($7500.00) dollars for the fiscal year from July 1st, 1921 to June 30th, 1922, inclusive, and the sum of Seven Thousand Five Hundred ($7500.00) dollars for the fiscal year from July 1st, 1922, to June 30th, 1923, inclusive, provided that any balance remaining in the treasury from said first fiscal year shall be transferred by the treasurer to said second fiscal year and may be expended during said second fiscal period for the same purposes.

Section 5. All acts or parts of acts in conflict with this Act are hereby repealed.

Soil surveys have been made of sixteen counties of Arkansas, a list of which will be found at the end of this book. The reports are distributed through the U. S. Bureau of Soils, Washington, D. C.

Mine Inspection Law, Governing Operation of Mines in General

(Digest of the Statutes of Arkansas, 1921)

MINE INSPECTOR

Section 7249. **Appointment—qualifications—salary.** A mine inspector shall be appointed by the Governor immediately upon the taking effect of this act, who shall hold office until the first day of July, 1919, and until his successor shall have been appointed and qualified, after which the term of each mine inspector shall begin on the first day of July of every odd numbered year and shall continue for two years, and until his successor is appointed and qualified, and all appointments shall be made by the Governor of the State, and said mine inspector shall not, while holding office, be connected with or engaged, directly or indirectly, as owner, operator, agent or director of any coal mine or other mining interest. He shall have had eight years' actual experience as a practical miner. He shall have an office, which shall be located in Fort Smith, Ark., and shall safely keep all records, papers, documents, and other property pertaining to or coming into his hands by virtue of his office, and deliver same to his successor. Said mine inspector shall receive as salary for his services the sum of $2000 per annum.

Section 7250. **Bond.** The mine inspector, before entering upon the duties of his office, and within 20 days after his appointment, shall make and execute a bond to the State of Arkansas, with one or more sufficient sureties, in the sum of $5000, conditioned upon the faithful performance of his duties; same to be approved by the Governor. When said bond is so approved, he shall also take oath of office prescribed by the Constitution; and in the event that said mine inspector shall fail to make and execute said bond within the time prescribed by this act, his appointment shall be declared void, and it is hereby made the duty of the Governor to appoint and have qualified a proper person in his stead, as contemplated by the provisions of this act.

Section 7251. **Expenses.** Said mine inspector shall be allowed all necessary postage, stationery and other expenses of a similar character necessary for the transaction of the business of the office; and the said salary and expenses shall be paid as in the case of other State officers. In addition to the salary, necessary traveling expenses while in the performance of the duties of the office shall be allowed; but the total expenses, in addition to salary paid, shall not exceed $1000 per annum.

Section 7252. **Inspection and reports.** The mine inspector shall devote his entire time to the duties of the office. It shall be the duty of the mine inspector to examine all mines as often as necessary, and not less than once every three months; provided, however, that employes of any mine, as contemplated by the mining laws of this State, shall have authority to call said mine inspector at any time in cases of emergency for the enforcement of the mining laws of this State. Inspections shall be made of the works and machinery used or operated by any mine; also the State and condition of the mines as to ventilation, circulation and condition of the air, drainage, and the number of accidents, injuries or deaths occurring in or about the mine, number of persons employed, and the extent to which the laws relating to mines and mining are observed; the progress made in improvements for the safety and health sought to be obtained by the provisions of the mining laws of this State, together with all other such facts and information of public interest concerning the conditions of mine development and progress in this State as may be deemed useful and proper; and to keep a complete record of same, which shall be included in the mine inspector's annual report to the Governor. Should the mine inspector find any violations of the mining laws of this State by any owner, lessee or agent in charge of any mine, notice shall immediately be given to such owner, lessee or agent in charge of such mine of the neglect or violation thereof, and unless the same is, within a reasonable time, rectified, the mine inspector shall institute a prosecution under the laws of the State, as here-

inafter provided. If the said mine inspector find any matter, thing or practice in or connected with a mine to be dangerous or defective, which makes it unsafe for persons employed therein, notice in writing thereof to the owner, lessee or agent of such dangerous or unsafe condition shall be given, and the said conditions shall, by the said owner, lessee or agent be remedied without unnecessary delay. For the purpose of making the inspection and examination as contemplated by this act, the mine inspector shall have the right to enter any mine at any reasonable time, by day or night, but in such manner as shall not necessarily obstruct the workings of said mine, and the owner, lessee or agent is hereby required to furnish the means necessary for such entry and inspection. The inspection and examination, as contemplated by this act, shall extend to all coal mines where the same are operated by shaft, slope or drift.

Section 7253. **Owners to facilitate examinations.** The owner, agent or operator of such mine is required to furnish all necessary facilities for entering and making such examinations and inspection, and if the owner, agent or operator aforesaid shall refuse to permit such inspection, or to furnish the necessary facilities for entering and making such examinations and inspections the inspector shall file his affidavit, setting forth such refusal before the judge of the circuit court in the county in which said mine is located, and said judge of said court is granted the power to issue an order, commanding said owner, agent or operator to appear before said judge at chambers or before the circuit court to show cause why he refuses to permit said inspection or furnish the necessary facilities for entering and making said examinations; and, upon hearing, the judge of the court shall have the power to fine such agent, owner or operator in any sum not less than $50.

Section 7254. **Complaint—duties of judge.** If the said inspector shall, after examination of any mine and the works and machinery pertaining thereto, find the same worked contrary to the provisions of this act, or unsafe for the workmen employed therein, the said inspector shall file a complaint before the judge of the circuit court in vacation or the circuit court when in session, in the name of the State, without cost or bond, showing wherein the said owner, agent or operator has failed to comply with the provisions of this act, and the said court or judge, after hearing the cause, shall, if satisfied the law has not been complied with, restrain or enjoin the said owner, agent or operator from operating the said mine until the law is complied with. In all proceedings before the said court or judge, the owner, agent or operator shall have two days' notice of the intended application for restraining order, and the judge of the court shall hear the complaint on affidavits or other testimony that may be offered in support as well as in opposition thereto, and, if sufficient cause appear, the court or judge in vacation by order shall prohibit the further workings of any such mine in which persons may not be safely employed or which is worked contrary to the provisions of this act until the same has been made safe and the requirements of this act shall have been complied with, and the court shall award such costs in the matter of said proceedings as may be just, but any such proceedings so commenced shall be without prejudice to any other remedy permitted by law for enforcing the provisions of this act.

D State vs. Southern Anthracite Coal Mining Co., 13 Ark. 593.

Section 7255. **Arrests—proceedings.** The mine inspector is hereby empowered concurrently with the sheriffs and constables throughout the State to make (arrests) for any violations of the mining laws of the State, but he shall make no arrests until after notice has been given as provided in this act. Where, in the opinion of the mine inspector, there is imminent danger to the life or health of the miners or employees in said mine said inspector shall at once notify the person in charge of or operating said mine in which the dangerous condition exists to immediately remove said danger, and, on failure to remove said dangerous condition without unnecessary delay, said inspector shall order the mine, or dangerous portion thereof, cleared of all persons except those necessary to remove or remedy said dangerous condition. Upon the clearing of any mine of persons em-

ployed therein, as herein provided, any owner, lessee or agent in charge of or operating any such mine may apply to the chancery court within the jurisdiction of said mine for a writ of injunction to enjoin the mine inspector from continuing the prevention of the operation of said mine. Whereupon the chancellor of said court, either in term or vacation, shall at once proceed to hear and determine the case, and if the cause appears to be sufficient after hearing the parties and their evidence, as in like cases, the chancellor shall sustain or overrule the mine inspector.

Section 7256, **Obstructing inspection—penalty.** Any person who shall wilfully obstruct or hinder the mine inspector in the discharge of his duties, and every owner, lessee or agent, or manager of a mine who shall refuse or neglect to furnish the mine inspector the means necessary for making entry, inspection, examination or inquiry under the mining laws of this State, shall be deemed guilty of a misdemeanor, and upon conviction shall be punished as hereinafter provided. Should the mine inspector wilfully fail or refuse to perform any of the duties required under the provisions of the mining laws of this State, he shall be deemed guilty of a misdemeanor, and upon conviction shall be fined in a sum not less than one hundred dollars nor more than one thousand dollars, and, upon a second conviction for such failure or refusal, shall be removed from office by the Governor, and his successor appointed within thirty days from the date of such removal. Any owner, or agent, lessee, or other person convicted of the violation of any of the provisions of the mining laws of this State or failing in any manner to comply therewith shall be deemed guilty of a misdemeanor and upon conviction shall be fined in any sum not less than fifty dollars nor more than five hundred dollars except where provisions of the mining laws otherwise provide penalties. Each day any such violation or failure shall continue on the part of any owner, agent, lessee, or other person shall be deemed as a separate offense. Provided, that the provisions of this act do not apply to coal mines where less than ten men are employed underground in twenty-four hours.

Section 7257. **Duty of prosecuting attorney.** It shall be and is hereby made the duty of the prosecuting attorney in the district wherein the mine inspector shall arrest or cause to be arrested any person or persons violating the provisions of the mining laws of the State to at once take charge of and prosecute the same with reasonable diligence.

Section 7258. **Construction.** This act shall not repeal any of the mining laws of the State, except wherein it specifically conflicts, but shall be cumulative to all mining laws now in force.

Section 7559. **Non-performance of duty of Inspector.** Any inspector who shall wilfully fail or refuse to perform any of the duties required of him by the provisions of this act shall be punished by a fine of not less than one hundred dollars, and, upon third conviction for any such failure or refusal, he shall be removed from office, and any other person convicted of a violation of any provision of this act, or failing in any manner to comply therewith, except such provision for which punishment has already hereinbefore been fixed, shall be punished by a fine of not less than twenty-five dollars; and each day any such violation or failure shall constitute a separate offense; provided, the provisions of this act do not apply to mines when less than ten men are employed underground in twenty-four hours.

Section 7260. (Amended). **Furnishing map or plans.** The owner, agent or operator of each and every coal mine in this State shall make, or cause to be made, an accurate and correct map or plan of the entire workings of said mine, and every vein or deposit thereof, showing the general inclination of the strata together with any material deflections in the said workings, and the boundary lines of said mine, and deposit a true copy of said map or plan with the Clerk of the County Court of each County wherein said mine or any part thereof may be located, and the same shall be so deposited during the month of January of each and every year hereafter, and such owner, agent or operator shall file a copy of said map or plan with the Mine Inspector during the month of January of each year and shall also keep a copy of same open for inspection at the office of such owner, agent or operator, and shall furnish said clerk and inspector with a

sworn statement and further map or plan of the progress of the workings of such mine from the date of the last report to the ending December next preceding the making of same, and the inspector shall correct his map or plan in accordance therewith, and when any mine is worked out or abandoned that fact shall be reported to the inspector without delay, and the map or plan in the office of the clerk aforesaid shall be corrected and verified to conform to the facts then existing.

All mine maps or plans aforesaid must show the location of doors overcast or air bridges, and the direction all air currents are traveling shall be indicated thereon by arrows. The Clerk of the County Court in which mines are located, shall file and safely keep all maps and plans of any mine deposited in his office, and same shall be recorded as maps and plans of town sites are now recorded. The Mine Inspector shall send maps and plans of mines in his possession to the Secretary of State for safekeeping at the end of every two years, during the month of July, and said mine maps and plans shall be kept in a vault for this special purpose for the guidance of anyone interested therein.

Section 7261. (Amended). **Instruction to make map or plan.** That the owner, agent or operator of any mine neglecting, failing or refusing to furnish said Inspector and County Clerk, a statement, map or plan or addition thereto at the time, and in the manner provided above shall be deemed guilty of a misdemeanor and on conviction thereof shall be fined in any sum not less than $100.00 nor more than $500.00 and each day such neglect, failure or refusal shall continue shall constitute a separate offense. This penalty shall be in addition to the rights now conferred upon the Mine Inspector by law to have said maps or plans made at the expense of the owner, agent, or operator. This Act shall not be construed as repealing any law now in effect except where same shall be in direct conflict herewith, and this act shall be cumulative to existing laws regulating mines.

Section 7262. **Escapement shaft.** In all mines that are or have been in operation prior to the first day of January, 1893, and which are worked by and through a shaft, slope or drift, if there is not already an escapement shaft to each and every such mine or communication between each and every mine and some other contiguous mine, then there shall be an escapement shaft or other communication such as shall be approved by the mine inspector, making at least two distinct means of ingress and egress, for all persons employed or permitted to work in such mines. Such escapement shaft or other communication with a contiguous mine aforesaid shall be constructed in connection with every vein or stratum of coal in such mine and the time to be allowed for such construction shall not exceed ninety days from the time this act takes effect, and such escapment shaft or other communication with contiguous mines aforesaid shall be constructed in a shorter time than ninety days, if within the discretion of the inspector it becomes necessary, and in all cases where the working force of one mine has been driven up or into the workings of another mine, respective owners of such mines while operating the same shall keep open a roadway not less than six feet wide nor less than three feet high, thereby forming a communication as contemplated by this act, and for the failure to do so shall be subject to the penalty provided for in Section 7253, for each and every day such roadway is unnecessarily closed; each and every escapement shaft shall be separated from the main shaft by such extent of natural strata as shall secure safety to the men employed in such mines, not less than one hundred feet, in all mines that shall go into operation for the first time after the first day of January 1893; such an escapement or other communication with a contiguous mine, as aforesaid, shall be constructed within ninety days after such mine shall have been put into operation, or within a shorter time if in the descretion of the inspector it becomes necessary; and it shall not be lawful for the owner, agent or operator of any such mine as aforesaid to employ any person to work therein or permit any person to go therein for the purpose of working except such persons as may be necessary to construct such escapement shaft, unless the requirements of this section shall first have been complied with. And the term "owner," as used in this act, shall mean the immediate proprietor, lessee or occupant of

any mine or any part thereof and the term "agent," shall mean any person having on behalf of the owner, the care or management of any mine or part thereof; provided, nothing in this section shall be construed to extend the time allowed by law for constructing escapement shaft.

Section 7263. **Ventilation.** The owner, agent or operator of every mine, whether operated by shaft, slope or drift, shall provide and maintain for every such mine a sufficient amount of ventilation, to be determined by the inspector, not less than one hundred cubic feet of air per man per minute, measured at the foot of the downcast, which shall be circulated to the face of every working place throughout the mine, so that said mine shall be free from standing gas of whatsoever kind. In all mines where fire damp is generated every working place where fire damp is known to exist shall be examined every morning with a safety lamp by a competent person before any other persons are allowed to enter. The ventilation required by this section may be produced by any suitable appliance, but in case a furnace shall be used for ventilating purposes, it shall be built in such a manner as to prevent the communication of fire to any other part of the works by lining the upcast with incombustible material for a sufficient distance from said furnace.

Section 7264. **Bore-hole.** The owner, agent or operator shall provide that a bore hole shall be kept twenty feet in advance of the face of each and every working place, and if necessary on both sides when driving toward an abandoned mine, or a part of a mine suspected of containing inflammable gases or to be inundated with water.

Section 7265. **Means of signalling—cages.** The owner, agent or operator of every mine, operated by shaft, shall provide suitable means for the signalling between the bottom and top thereof; and shall also provide safe means of hoisting and lowering persons in a cage, covered with boiler iron, so as to keep safe as far as possible persons descending into or ascending out of said mine; and such cage shall be furnished with guides to conduct it through slides through such shaft with sufficient brake on every drum, to prevent accident in case of the giving out or breaking of the machinery; and such cage shall be furnished with spring catches, intended and provided, so far as possible, to prevent the consequences of cable breaking or the loosening or disconnecting of the machinery; and no props or rails shall be lowered in the cage while men are descending into or ascending out of said mine; that when men are ascending or descending, the opposite cage in every case shall be empty.

Section 7266. **Age of minors—management of cages.** No person under the age of fourteen years, or female of any age, shall be permitted to enter any mine to work therein; nor shall any boy under the age of sixteen years, unless he can read and write, be allowed to work in any mine, and no owner, agent or operator of any mine operated by a shaft or slope shall place in charge on any engine whereby men are lowered into or hoisted out of the mines by any but an experienced, competent and sober person, not under 18 years of age, and no person shall be permitted to ride upon a loaded cage or wagon used for hoisting purposes in any shaft or slope except persons employed for that purpose, and in no case shall more than eight persons ride in any cage or car at any one time, nor shall any coal be hoisted out of any mine while any person or persons are descending into such mine, and in no case shall more than one of the same family ascend or descend into any mine in one cage at one time, nor shall they be lowered or hoisted more rapidly than 500 feet per minute.

Section 7267. **Gates, bonnets and safety appliances.**.. The owner, agent or operator shall cause every landing on a level or above the surface of the ground, and the entrance to each intermediate vein (to be) securely fenced by gate and a bonnet so prepared to cover and protect such shaft and the entrances thereto, and the entrance to every abandoned slope, air or other shaft shall be securely fenced off, and every steam boiler shall be provided with proper steam gauge, water gauge and safety-valve and all underground self-acting or engine plains or gangways on which cars are drawn and persons allowed to travel shall be provided with some proper means of signaling between stopping places and the end of such plains or gangways, and sufficient places of refuge at the side of such

plains or gangways shall be provided at intervals not more than thirty feet apart.

Section 7268. **Report of accidents—investigations.** Whenever loss of life or serious personal injury shall occur by reason of an explosion or of any accident whatever in or about any mine, it shall be the duty of the person having charge of such mine to report the facts thereof without delay to the mine inspector, and, if any person is killed thereby, to notify the coroner or some justice of the peace of said county, and it shall be the duty of the inspector to investigate and ascertain the cause of said explosion, and file a report thereof with the other records of his office; and, to enable him to make such investigations, he shall have power to compel attendance of witnesses, and take depositions, administer oaths, and the cost of the examination shall be paid by the county as costs of coroner's inquests are now paid, and the failure of the person in charge of the mine where the accident occurred to give the inspector notice thereof shall be a misdemeanor.

Section 7269. **Right of action for injury.** For any injury to persons or property occasioned by wilful violation of this act, or wilful failure to comply with any of its provisions, a right of action shall accrue to the party injured for any direct damages sustained thereby; provided should death ensue from such an injury, a cause of action shall survive in favor, first, of the widow and minor children of such deceased; if there be no widow nor minor children, then to the father if living, then to the mother; if no mother, then to the brothers and sisters and their descendants.

Section 7270. **Injury to appliances—penalty.** Any miner, workman or other person who shall knowingly injure any water-gauge, barometer, air course or brattice, or shall obstruct or throw open any air way, or carry any lighted lamps or matches into places that are worked by safety lamps or shall handle or disturb any part of the machinery of the hoisting engine, or open a door to a mine, and not have the same closed again, whereby danger is produced, either to the mine or those who work therein; or who shall enter any part of the mine against caution, or who shall disobey an order given in pursuance of this act, or who shall do any wilful act whereby the lives and health of persons working in the mine, or the security of the mine, or miners, or the machinery thereof is endangered, shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be punished by a fine or imprisonment at the discretion of the court.

Section 7271. **Prop timbers.** The owner, agent or operator of any mine shall keep a sufficient amount of timber when required to be used as props, so that the workmen can at all times be able to properly secure the said workings from caving in, and it shall be the duty of the owner, agent or operator to send down all such props when required and deliver said props to the place where cars are delivered.

Section 7272. **Duties of weighman and checkman.** The weighman employed at any mine shall, before entering upon his duties, take and subscribe an oath, or affirmation, before some proper officer, to do justice between employer and employee, and to weigh the output from the mine honestly and correctly. The miners engaged in working any mine shall have the privilege, if they so desire, of selecting, by a majority vote, and employing, at their own expense, a check weighman, who shall in like manner take an oath, and who shall have like rights, powers, and privileges, in attending and seeing that the coal is correctly weighed, and who shall be subject to the same penalties as the regular weighman, and each of such weighman shall keep account of all coal weighed at the mines, in a well bound book kept for that purpose. Such oath or affirmation shall be kept posted in a conspicuous place in the weigh office and every owner, agent or operator of any coal mine in this state shall keep a correct account of the output of coal at his mine in a well bound book kept for that purpose, therein showing the amount of coal mined in each day, in each month and in each year, and such account shall be kept in the general office in this State of such owner, agent or operator ,subject at all times to the inspection of the inspector, and if the mine be leased, subject also to the inspection of the owner of the mine, his agent or attorney.

Section 7273. **Scales and measures.** It shall be the duty of every cor-

poration, company or person engaged in the business of mining and selling coal by weight or measure, and employing ten or more persons, to procure and constantly keep on hand at the proper place the necessary scales and measures and whatever else may be necessary to correctly weigh and measure the coal mined by such corporation, company or person and it shall be the duty of the mine inspector to visit each coal mine operated therein, and where such scales and measures are kept at least once in each year, and test the correctness of such scales and measures. The owner or operator of each coal mine, or any two or more of the miners working therein, may, in writing, require his attendance at the place where such scales and measures are kept at other times in order to test the correctness thereof, and it shall be his duty to comply with such request as soon as he can after receiving such request.

Section 7274. **Testing weights.** Every agent, owner, lessee or operator engaged in mining coal in any quantity, where ten or more men are worked underground, shall furnish and keep on hand for the use of the State Mine inspector, for inspecting, testing and examining scales, five hundred pounds of United States testing weights.

Section 7275. **Penalty.** Any corporation or person violating any of the provisions of this section shall be deemed guilty of a misdemeanor, and upon conviction thereof shall, for each offense, be fined not less than twenty-five dollars and not more than five hundred dollars; and the officers, agents or employees of the corporation or company whose duty it was to do or perform the act, or to cause it to be done and performed, which is the subject of the indictment, may be indicted jointly with said corporation or company, and upon conviction thereof be fined in any sum not less than twenty-five dollars nor more than five hundred dollars.

Section 7276. **Coal not screened until weighed—exception.** It shall be unlawful for any mine owner, lessee or operator of coal mines in this State, where ten or more men are employed underground, employing miners at bushel or ton rates, or other quantity, to pass the output of coal mined by said miners over any screen or any other device which shall take any part from the value thereof before same shall have been weighed and duly credited to the employee sending the same to the surface ,and accounted for at the legal rate of weights as fixed by the laws of Arkansas, and no employee within the meaning of this act shall be deemed to have waived any right accruing to him under this section by any contract he may make contrary to the provisions thereof, and any provision, contract, or agreement between the mine owners, lessees or operators thereof, and the miners employed therein whereby the provisions of this act are waived, modified or annulled, shall be void and of no effect, and the coal sent to the surface shall be accepted or rejected; and, if accepted, shall be weighed in accordance with the provisions of this act, and the right of action shall not be invalidated by reason of any contract or agreement; provided, that in Cane Creek, River and Logan townships in Logan county, and in all of Johnson county except Grant township, all the coal mined and paid for by weight may be paid for on the mine run basis, or upon the screen coal basis, which shall be a matter for agreement between the operators and the miners. Provided, further, that if any coal shall be mined on the screen coal basis it shall pass over the following kind of screen, to-wit: The screen shall not be more than four feet wide and not more than twelve feet long, made of steel or iron bars which shall not be less than five-eighths of an inch in thickness on the face and not less than five-sixteenths of an inch in thickness on the bottom and not less than 1¼ of an inch shall be supported by rests or cross bars. It shall in no event be placed more than three feet apart. The screen bars shall be placed upon rests in such a manner as to prevent spreading and said rests or cross bars shall be firmly fastened to each side of the chute through which the coal passes. Said rests or cross bars shall be so arranged as in no case to rise above the top of the screen bars in such a manner as to retard the speed of the coal in passing over the screen. Where coal is screened before it is weighed, it shall be dumped upon bat sheets and passed over the screen as described above, and there shall be no obstruction on said screens,

Any owner, agent, lessee or operator of any coal mine in this State where ten or more men are employed under ground, who shall knowingly violate any of the provisions of this section, shall be deemed guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than two hundred dollars nor more than five hundred dollars for each offense, or, by imprisonment in the county jail for a period of not less than sixty days nor more than six months, or both such fine and imprisonment; and each day any mine or mines are operated thereafter shall be a separate and distinct offense; proceedings to be instituted in any court having competent jurisdiction.

Section 7277. **Room and pillar plan—regulation.** The owner, agent, lessee, or operator of any coal mine in this State, if said mine is worked on the room and pillar plan, shall cause such work to be prosecuted in such mine in the following manner, to-wit: Two entries parallel with each other must be driven for the ingress and egress of the air, and cross cuts must be made at intervals not to exceed forty feet apart. Where gas exists they shall be driven thirty feet apart, or a cross cut be made at any other place ordered by the management to do so. No room shall be turned inside the last course cut.

Section 7278. **Enforcement.** The State Mine Inspector shall, after the passage of this act, give notice in writing to the owner, agent, lessee or operator in charge of each coal mine worked on the room and pillar plan, to conform to the requirements hereinbefore set out, and if the same are not complied with in such mines as work ten or more men underground, the such owner, agent, lessee, or operator so failing shall be deemed guilty of a misdemeanor, and, on conviction, be fined not less than ten or more than fifty dollars for each day in which such mine is operated in violation of the above requirements.

Section 7279. **Daily inspection.** In all mines where a fire boss is employed, all working places and worked-out places adjacent to the working places shall be examined, when it can be done, at least once a day by a competent fire boss, whose duty it shall be to enter a report of existing conditions of such working places and worked-out places in a well-bound book, to be kept by him for that purpose, and all dangerous places that are marked out shall be marked on a blackboard, furnished by the company, before any other employee enters the mine.

Section 7280. **Lard oil for lighting.** Nothing but pure lard oil, where oil is used for lighting purposes, shall be used in any underground works, except in the main upcast. This section shall not apply to rope riders.

Section 7281. **Emergency supplies.** There shall be kept in the engine room, or at some nearby and convenient place, at each mine working ten or more men underground, a supply of oils, bandages, blankets or covers for wraps, and a cot or stretcher, for use of and to be used by persons who may receive injuries in or at said mines, and the owner, agent, lessee, or operator shall also provide and maintain at some convenient place a conveyance in which to take from the mines to their place of abode, persons who may be thus injured.

Section 7282. **Annual report of coal mined.** Each and every owner, agent, lessee, or operator operating a coal mine in this State shall annually, on the 1st day of July of each year, make a report, under oath, upon blank forms to be furnished by the State Mine Inspector, of the true amount of coal mined each and every month for twelve months next preceeding the making of said report. The said blank forms shall be prepared by the State Mine Inspector, and contain the necessary headings and columns to obtain a correct and true statement of all coal of every kind mined; and this section shall apply to all mines without regard to the number of men employed.

Section 7283. **Penalty.** Any owner, agent, lessee, or operator who shall fail or refuse to file, swear to, and return by the 1st day of July of each year the said reports, shall be deemed guilty of a misdemeanor, and on conviction shall be fined not less than twenty-five dollars nor more than one hundred dollars for each day of such failure; and any agent, owner, lessee, or operator who knowingly swears to a false report, shall be deemed guilty of perjury, and punished accordingly.

Section 7284. **Air currents.** All slopes, drifts or shafts, used for hoisting or hauling coal shall be made the intake of air into the mines except at the opition of the owner or by the direction of the State Mine Inspector, and that all air that goes into a mine shall be so split that not more than fifty employees will be working on each split of air, and there shall not be less than 200 cubic feet of air pass each working face per minute, and it shall be the duty of the State Mine Inspector to measure the air at all working places in making his inspection. The machinery and appliances used for conducting or driving the air into the mines shall be so installed, arranged and adjusted that said air currents may be easily and speedily reversed in emergencies.

Section 7285. **Miners called out of dangerous mines.** Whenever and wherever a coal mine in this State becomes dangerous from high water or overflow of streams adjacent thereto, whereby the lives of the miners employed therein are jeopardized by reason of such high water, it shall be the duty of the managers of such coal mine to call the miners out of the same, and forbid their working therein until such danger is past, and failure to do so is hereby made a high misdemeanor, and, upon conviction thereof, shall be fined in any sum not less than five hundred dollars nor more than five thousand dollars, or by imprisonment not less than six months nor more than one year.

Section 7286. **Failure of lessee to report output.** Any person, firm or corporation, leasing lands in this State under written contracts providing for a royalty to be paid the lessor for ore deposits or minerals taken out or off of said land, or any officer, agent or employee of said lessee, who shall with the intent to defraud the said lessee out of any part of said royalty fail, neglect or refuse to report the true amount or quantity of ore, deposits or minerals taken from said lands, or who shall conceal the true amount so taken, or who shall falsely report the amount so taken, shall be deemed guilty of a felony, and shall upon conviction, be imprisoned in the penitentiary for not less than one nor more than five years.

WASH HOUSES IN COAL MINES

Section 7287. **Duty to furnish.** It shall be the duty of every owner or lessee, its officers and agents, or other persons having jurisdiction or direction of any coal mine or coal mines employing ten or more persons, within the State of Arkansas, to provide, within ninety days after the passage and approval of this act, a suitable building which shall be convenient to the principal entrance of such mine or mines, and equipped with individual lockers or hangers, benches or seats, proper light, heat, hot and cold water and shower baths, and maintain the same in good order, for the use and benefit of all persons employed in or about said mine or mines. Said building shall be so constructed as to give sufficient space for the accommodation of miners or others using the same. The flooring in the wash room of said building to be made of concrete or cement, but the material used in flooring in the changing room shall be optional with the owner, lessee operating or directing the operation of the mine or mines. All lockers required by this act, when made of steel, shall be not less than twelve inches in width, twelve inches in depth and sixty inches in height. When made of lumber, they shall not be less than twelve inches in depth, twelve inches in width and sixty inches in height, with partitions in center of wood lockers. Individual hangers shall consist of not less than three suitable hooks upon which to hang clothing and a receptacle of suitable size for use in connection therewith, attached to a proper chain or wire rope, and so suspended as to admit of hanger being raised to such height that wearing apparel, when hung thereon, will not be less than seven feet above the floor of said building and of being locked in that position. The lockers and hangers in each wash house shall be sufficient in number to accommodate all employees of said mine or mines and there shall be one shower bath for each fifteen employees. Said employees shall furnish their own towels, soap and lock for their lockers or hangers, exercising control over and be responsible for the property by them left therein; and it shall be the duty

of all persons using said wash houses to remove therefrom all cast-off wearing apparel.

Section 7288. **To be kept clean.** Every corporation, company, partnership, person or persons who shall construct any building or buildings required by Section 7287, and shall install such house and wash house facilities as required therein, shall at all times, during the operation of any mine or mines, keep same in clean and sanitary condition, but shall not be liable for the loss or destruction of any property of employees left in any such building or buildings.

Section 7289. **Penalty.** Any owner, lessee, its officers or agents, or other persons failing or refusing to comply with the provisions of this act shall be deemed guilty of a misdemeanor, and shall upon conviction, be fined not less than $50 nor more than $100; each day's violation shall constitute a separate offense and shall be punished as such.

Section 7290. **Injury to appurtenances—penalty.** It shall be unlawful for any person to break, injure or destroy any part or appurtenance to any wash house, or commit any nuisance therein; and any person adjuged guilty of a violation of this section shall be fined in any sum not less than $25 nor more than $50.

Section 7291. **Separate wash houses.** All coal mines operating in this State shall by partition, or by other means, in the discretion of the State Mine Inspector, maintain separate wash houses for whites and b'acks.

Section 7292. **Duty of Inspector.** It shall be the duty of the State Mine Inspector, and he is by this act authorized to require wash houses already in existence to be so changed, remodeled and improved as to comply with the provisions of this act. He shall have general supervision of this law and its enforcement.

LIEN OF MINERS

Section 7293. **Lien on output and machinery.** Any person or persons working in any mines of the State of Arkansas, or in any quarries, either stone or marble, shall have a lien on the output of any such mines or quarries for the amount due for such work, and, in addition thereto, his lien shall attach to all machinery, tools and implements used in such quarrying and mining, such liens to be enforced in the manner now provided or as may hereafter be provided for the enforcement of laborer's liens.

RIGHT TO OPERATE ON RAILWAYS OR TRAMWAYS

Section 7294. **Short line roads authorized.** A person owning or controlling, by lease or purchase, any copper, lead, zinc, iron, marble, stone, rock, granite, slate, coal or other mineral lands in this State shall have the same right to incorporate, own, construct and operate such short lines of railway or tramway as may be necessary to the successful mining, quarrying and marketing of said coal, marble, stone, rock, granite, slate and other mineral.

Section 7295. **Eminent domain.** All incorporations herein provided for shall be governed by the laws governing railway incorporations in this State; and shall have the same right to acquire right-of-way over, under or through any private or public lands, and shall have and exercise the same right of eminent domain in acquiring such right-of-way; and shall have the same authority to construct, own, lease, operate, or sell such lines of railway, or tramway, as may be necessary to the successful mining and marketing of such coal and other minerals, owned or controlled by said mining corporations in this State.

Section 7296. **Rights as carrier.** When so incorporated and constructed, such short lines of railway and tramway shall be and are hereby entitled to all the rights, powers and privileges of a common carrier.

Section 7297. **Rights to connections, crossings, etc.** All such short lines of railway, or tramway, shall have the same rights and privileges of connections, crossings, sidings, switches and transfer, without prejudice or discrimination, as are extended by custom or granted by law to railroad corporations in this State.

Section 7298. **Passenger equipment not required.** All such short lines of railway, or tramway, not exceeding six miles in length, shall not be required to maintain passenger equipment, but if, at their option, they carry passengers, they shall be subject to the laws governing passenger traffic on railroads in this State.

Coal Mine Examining Board

(Digest of the Statutes of Arkansas, 1921.)

Section 7317 **Examining board.** Immediately after the passage of this act, there shall be appointed by the Governor, a board of four examiners to serve until July 1, 1921, and thereafter such board of examiners shall be appointed for a term of four years. Two of said board shall be practical miners, who have had at least eight years' experience as miners in mines of Arkansas or elsewhere; two shall be operators of coal mines in the State of Arkansas or representatives thereof. One additional member of said board shall be selected by the four members appointed as hereinbefore provided. The Members of the examining board shall be paid out of the coal mine examiners' fund, upon vouchers to be approved by the president of said board, the sum of $6 per day for each day of actual service and their necessary expenses.

Section 7318. **Organization and duties.** Immediately after their appointment, the examiners shall meet and organize by selecting a chairman and secretary. The secretary shall keep on file all examination questions and their answers, and all examination records and papers belonging to the board. The examining board shall convene upon call of the chairman, except in case of emergency. Notices shall be published in one newspaper of general circulation in each county in which there are coal mines, at least five days before the day of meeting.

Section 7319. **Employees to be examined—fees.** On and after the passage of this act no fire bosses, hoisting engineers, or mine foremen shall be employed in any mines in the state of Arkansas, unless they shall have been examined by the said State Board of Examiners, as hereinafter provided.

And provided, further, that no one shall act as mine instructor or assistant mine instructor of the State of Arkansas, unless they have been examined by said board of examiners, as hereinafter provided.

Provided, that the mine inspector holding office at the time this act goes into effect shall have a fee of $10 and be granted a certificate without examination, and the assistant mine inspector holding office at the time this act goes into effect, shall, on payment of a fee of $7.50, be granted a certificate without examination.

Provided, that men holding positions of hoisting engineers, or mine foremen, at the time this act goes into effect, who have had five years' experience and pay a fee of $5, shall be granted certificates without examination.

Fire bosses, holding positions at the time this act goes into effect, who have had five years' experience and pay a fee of $3, shall be granted a certificate without examination. Applicants for examination shall be able to read and write the English language, and shall satisfy the board of examiners that they are of good moral character, and not be a user of intoxicating liquors, and shall be a citizen of the United States. All applicants shall be thoroughly examined with reference to the duties of the positions for which they have applied for certificate. Applicants for certificates as mine foremen shall be at least 25 years old, and shall have had at least five years' experience as practical coal miners, mining engineers or men of general underground experience. Applicants for certificates as fire bosses shall have like qualifications and experience in the mines of Arkansas or elsewhere and shall also have had experience in mines that generate explosive and noxious gases. Applicants for certificates as mine inspector shall, before examination, pay to the board a fee of $4, and, if successful a further fee of $6 for a certificate. Applicants for certificates as assistant mine inspector shall, before examination, pay to the board a fee of $3 and, if successful, a further fee of $4.50 for a certificate. Applicants for certi-

ficates as mine foremen and hoisting engineers shall, before examination, pay to the board a fee of $2 and, if successful, a further fee of $3 for a certificate. Other applicants shall, before examination, pay to the board of examiners a fee of $1, and, if successful, a further fee of $2 for a certificate.

Section 7320. **Certificates.** The board shall grant certificates after examination to all applicants who have shown themselves familiar with the duties of the position for which they desire certificates, and are capable of performing such duties. Provided, that certificates of the first grade shall be granted only to applicants who by oral or written examinations in the presence of and relating to explosive gas, have shown themselves competent to act as mine foremen in mines which generate explosive and noxious gases, and the certificate shall so state. Provided, certificates for mine inspector and assistant mine inspector shall be granted only to applicants who have shown themselves duly qualified, as provided by the law creating such office, and no appointments shall be made to such offices unless such appointee shall hold a certificate.

Section 7321. **Grade of certificate.** Anyone holding a first grade fireman's certificate may serve as foreman in any mine and may serve as fire boss; and anyone holding a second grade mine foreman's certificate may serve as any of the above, except as fire boss and foreman in mines which generate explosive or natural gases, and in case of emergency any mine owner, with the consent of the examining board, may employ any trustworthy or experienced man who shall not hold a certificate, for a period of not more than thirty days as mine foreman or fire boss.

Section 7322. **Forgery or counterfeit of certificate.** Any person who shall forge, alter or counterfeit a certificate, or shall secure or attempt to secure employment by use of such forged, altered or counterfeit certificate, or shall falsely represent that he is a holder of a certificate regularly issued him, shall be guilty of a misdemeanor.

Section 7323. **Duplicate certificates.** In case of loss or destruction of certificates, the secretary of the examining board, upon satisfactory proof of the said loss or destruction, may issue a duplicate thereof on the payment of the sum of $1.

Section 7324. **Revocation of certificates.** ..All certificates issued hereunder may be revoked by the board of examiners after hearing upon due notice to the holder of the certificate, and upon written charges preferred by the board or by some interested person for violation of this act. Complaint may be filed against the holder of a certificate for intoxication, mental disabilities, neglect of duty or other sufficient cause; provided, however, that the holder of the certificate so cancelled shall have the right to appear before the examining board after the expiration of three months and be reexamined, if he shall first satisfy the board that the incapacity complained of shall have ceased to exist.

Section 7325. **Penalty.** Any owner, operator, lessee or agent of any coal mine in the state of Arkansas, violating any of the provisions of this act, shall be deemed guilty of a misdemeanor, and upon conviction shall be fined not less than $10 nor more than $100, or be imprisoned in the county jail not exceeding one year, or both.

The office of the State Mine Inspector is at Fort Smith, Ark. The office of the State Bureau of Labor is at Little Rock, Ark.

Laws For the Conservation of Oil and Gas

(Digest of the Statutes of Arkansas, 1921)

Section 7299. **Duties of owners or operators.** The owner or operator of any well put down for the purpose of exploring for or producing oil or gas shall, during the course of such drilling, case off all fresh or salt water from each oil or gas producing sand encountered while drilling, such casing to be set in the well in such manner as to exclude all water from penetrating the oil or gas-bearing sand, and should such well be put down through the first into a lower oil or gas-bearing sand, the same shall be cased in such manner as to exclude all fresh or salt water, from all oil or gas-bearing sands encountered during the course of such drilling operation. And, should any well so drilled produce oil or gas-bearing sand such oil or gas shall be conserved by either casing or mudding it off, so as to confine it in the gas or oil-bearing sand where found; or, if it is to be utilized from different sands in the same well, it shall be taken through different strings of casing or tubing.

Section 7300. **Duty to confine gas.** Any person, co-partnership, corporation, owner, lessee or manager in possession of any well producing natural gas, in order to prevent said gas from wasting by escape, shall within ten days after this act takes effect, and thereafter within four days after penetrating the gas-bearing sand in any well drilled, shut in and confine the gas in said well until and during such time as the gas therein shall be utilized for light, fuel or steam power.

Section 7301. **Plugging dry or abandoned wells.** All lessees or operators drilling or operating for crude oil or natural gas within the State of Arkansas shall immediately, in a practical and workmanlike manner, under the supervision of the oil or gas inspector, as hereinafter provided, plug all dry or abandoned oil or gas wells in which oil or gas bearing stratum has been found, in the following manner: Beginning at the bottom of the hole, same shall be solidly plugged with a substance consisting of one-third portion cement and two-thirds portion of sand properly mixed with water to a point twenty-five feet above top level of the oil or gas-bearing sand. At that point a seasoned, wooden plug two feet in length and the diameter of the hole, shall be placed. Thereafter the hole shall be filled up solidly twenty-five feet with sand baling and a seasoned wooden plug, two feet in length and the diameter of the hole shall be so placed and driven firmly into the sand balings. Should there be more than one oil or gas-bearing sand in the well, after plugging the bottom sand in the well, as herein above set out, the well shall be filled with sand balings to within ten feet of the bottom of the next sand above that last plugged, when this sand and each succeeding sand shall be plugged in the manner herein above set out, until all the oil and gas-bearing sands in the well have been plugged as herein provided.

Section 7302. **Right of persons threatened with injury.** Whenever any person is injured or threatened with injury by the neglect to comply with the provisions of section 7301, it shall be lawful for such persons, after notice to the owner, lessee or caretaker of the premises upon which such well is located, to enter upon and fill up and plug such well in the manner herein provided; and thereupon to recover the expense thereof from the person or persons whose duty it was to fill up or plug such well in like manner as debts of such amounts are recoverable, and shall have a lien upon the fixtures, machinery, and leasehold interest of the owner or operator of such well for all sums expended in filling up and plugging such well, and for the costs of the suit, including a reasonable attorney's fee, to be fixed by the court.

Section 7303. **Penalty.** Any person, firm or corporation violating section 7299, 7300 or 7301 shall be subject to a penalty of not less than one hundred dollars or more than one thousand dollars to be recovered in an action therefore, brought by the prosecuting attorney in the name of the State, by the court. The proceeds of the penalties collected shall be turned into the general road fund of the county where incurred, to be used on the roads, bridges or highways of said county, in the discretion of the county court.

Section 7304. **Log of well drilled—filing.** It shall be the duty of the owner of any well drilled for gas or oil to keep a careful and accurrate log of the drilling of such well, such log to show the character and depth of the formation passed through or encountered in the drilling of such well, and particularly to show the location and depth of the water-bearing strata, together with the character of the water encountered from time to time, and to show at what point such water was shut off, if at all, and if not, so state in the log; and show the depth at which oil or gas strata is encountered, and the character of same, and whether all water overflowing or underlying such oil or gas-bearing strata was successfully and permanently shut off, so as to prevent the percolation or penetration into such oil or gas-bearing strata. The said log to be verified by the person in charge of the drilling attested as correct by the owners of the well, and shall be filed with the county clerk of the county in which said well is located, and preserved by him in the public records. The said log shall definitely describe the location of the well.

Section 7305. **Leaks—notice to owner.** It is hereby made the duty of any person discovering any leak in any pipe line for the transportation of natural gas, or in any machinery, apparatus or device used in the regulation, distribution or transportation thereof, forthwith to notify the owner of said pipe line or other appliance and also notify the gas inspector of said leak. It is made the duty of the owner of such pipe line or other apparatus from which gas is escaping, to immediately repair the same. It is made the duty of the gas inspector, on receiving reliable information of such leak, or on personal knowledge thereof, to forthwith notify the owner of said pipe line or appliance of it, and to immediately repair the same. Should the owner of such pipe line, apparatus, appliance or device fail to at once repair said leak, or use the utmost diligence to do so, he shall be subject to a penalty of not less than one hundred dollars nor more than one thousand dollars and a reasonable attorney's fee to be fixed by the court for the prosecuting attorney to be recovered in an action brought by the prosecuting attorney in the name of the State therefor. The proceeds of penalties collected shall be turned into the general fund of the county where the leak is located, to be used on the roads, bridges, or highways of said county, in the discretion of the county court.

Section 7306. **Permitting flow of gas—penalty.** It shall be unlawful for any person, firm or corporation having possession or control of any gas well whether as contractor, owner, lessee, or manager, to allow or permit the flow of natural gas of any such well to flow into the open air without being confined to such well or pipe, or other safe receptacles, for a longer period than three days after the gas shall have been struck and produced of such well. If such well cannot be confined in three days, the person controlling the same shall continue with the utmost diligence to confine it as soon as possible. Failure to comply with this section shall subject the person failing so to do to the penalties and proceedure provided in the next preceding section, which shall be applicable hereto.

Section 7307. **Civil liability.** In addition to the penalties described in the preceding section for failure to confine natural gas, any person or corporation lawfully in possession of lands upon which said gas well is situated, or adjoining or adjacent thereto, or in the vicinity of such well, may enter upon the lands on which such well is situated and take possession of such well from which said gas is allowed to escape in violation of such section, after the failure of the party in control thereof for ten hours to use the utmost diligence to confine the said gas, and pack and tube such well, and shut in and secure the flow of gas, and maintain civil action in any court of competent jurisdiction in this State against the owner, lessee, agent, or manager of such well, and each of them, jointly or severally, to recover the cost and expense of said tubing and packing, together with attorney's fees to be taxed as a part of the cost.

Section 7308. **Setting fire to escaping gas.** It is hereby declared to be unlawful for any person to set on fire any gas escaping from wells, broken or leaking mains, valves, pipes or other appliances used by any person, company or corporation in conveying gas to consumers, or in storing the same, or to interfere in any manner with wells, pipes, mains, gate-

boxes, valves, stop-cocks or other appliances, or machinery of any person, company or corporation, unless employed by or acting under the authority or direction of the person, company or corporation owning or controlling said wells, mains, pipes, valves, or other appliances, and those herein mentioned, or legal authority. Anyone found guilty of violation of this section shall be deemed guilty of a misdemeanor, and confined in the county jail not less than one day nor more than six months, and fined $25.00.

Section 7309. **Flambeau lights prohibited.** The use of natural gas for illuminating purposes in what are known as "flambeau" lights is wasteful and extravagant use thereof, and is dangerous to the public good, and it shall therefore be unlawful for any company, corporation or person to use natural gas for illuminating purposes in what are known as "flambeau" lights in cities, towns, highways or elsewhere; provided, this shall not be so construed to prohibit the use of such gas in what are known as "jumbo" burners, inclosed in glass globes, or lamps, or by the use of other burners of similar character, so inclosed as will consume no more gas than "jumbo" burners; provided, further, that this shall not apply to those engaged in drilling wells while the well is being drilled. A violation of this section shall subject the person so violating it to the penalties and proceedings provided in Section 7305, which is made applicable hereto.

Section 7310. **Gas inspector.** The office of gas inspector is hereby created. The gas inspector shall have at least three years' experience in natural gas drilling operations, and possess technical knowledge of the properties of natural gas, and of geology so far as it relates to the subject of natural gas. The Governor shall appoint such person as gas inspector and commission him as such, and shall serve for a term of four years, or until his successor is appointed and qualified, and he is hereby vested with the duties and rights and powers hereinafter prescribed.

Section 7311. **Notice of drilling—penalty.** When a company or individual drilling a well is required to plug it as provided in this act, he is to notify the gas inspector, who shall supervise the plugging and see that it conforms to the requirements of this act, and said gas inspector shall file a written report with the county clerk of the county in which the well is situated, stating in detail the work done, and he shall receive a fee of $25 from the company or individual owning the well. Should the company or individual plugging the well violate the provisions of this act in so doing, or in failing to do or the written directions of the gas inspector, it shall be subject to a penalty of not less than $100 nor more than $1,000 and the proceedure provided in Section 7305 which is made applicable hereto.

Section 7312. **Notice of plugging well—penalty.** When a company or individual drilling a well is required to plug it as provided in this act, he is to notify the gas inspector, who shall supervise the plugging and see that it conforms to the requirements of this act, and said gas inspector shall file a written report with the county clerk of the county in which the well is situated, stating in detail the work done, and he shall receive a fee of $25 from the company or individual owning the well. Should the company or individual plugging the well violate the provisions of this act in so doing, or in failing to do, or the written directions of the gas inspector, it shall be subject to a penalty of not less than $100 nor more than $1,000 and the procedure provided in Section 7305 which is made applicable hereto.

Section 7313. **Gas or oil-bearing sand—notice to inspector.** Any company or individual drilling a well shall notify the gas inspector whenever it reaches gas or oil-bearing sand or strata, whether said sand or strata are producing or not, and the inspector shall at once visit the well and see that the provisions of this act in regard to protecting said oil or gas-bearing sands or strata are complied with, and he shall receive a fee of $15 to be paid by the company, or individual drilling the well for his said services; provided the person drilling the well shall not be required to stop drilling until the inspector arrives. Failure of the individual or company drilling a well to comply with this act in regard to protecting gas-bearing or oil-bearing strata or sand, or to obey the written instruction of the gas

inspector, shall render the company or individual subject to a penalty of not less than $100 or more than $1,000 and subject to the same proceedure as provided in Section 7305, which is made applicable hereto.

Section 7314. **Duties of inspector—penalty.** The gas inspector shall inspect all gas wells in the process of drilling and all pipe lines in process of construction, and see there is no wastage of gas, and that said wells and pipe lines are properly constructed to prevent wastage. If he finds any water or wastage in well, pipes or other receptacle for gas, he shall at once notify the owner thereof, or, in his absence, the person in control thereof, of the same, with directions to immediately repair same, and failure thereof shall subject the owner or person in control thereof to a penalty of not less than $100 or more than $1,000 to be recovered as provided in Section 7305, which is made applicable thereto. Each person, company or individual, drilling or owning an oil or gas well shall pay an inspector fee of $10 to the gas inspector, and any person, firm or corporation constructing or owning a pipe line shall pay the inspection fee of $10 for each five miles or a fraction thereof.

Section 7315. **Defense to action for penalty.** In any action for penalty for failure to comply with directions of the gas inspector, the defendant may be permitted to show that the requirement was unreasonable and unnecessary, on proof of which the defendant shall be discharged.

Section 7316. **Amount of gas to be taken—penalty.** It shall be unlawful for any person, firm or corporation owning or operating any natural gas well, within the State of Arkansas, or selling gas therefrom, directly or indirectly, to draw from any well so owned or operated, in an amount exceeding in the aggregate 20 per cent of the open-flow test of the total volume of gas being produced out of the gas sands and said well; provided, however, if the rock pressure or volume of any gas producing area can be proved to have become depleted to such an extent that the gas will not flow of its own volition, and it becomes necessary to pump said gas, or by other artificial means procure gas from the aforementioned sands, then the first part of this section shall have no application while such condition exists. Any person, firm or corporation violating this section shall be subject to a penalty of $100 for each day or part of day of such violation; and this penalty may be recovered in an action therefor brought by the prosecuting attorney in the name of the State, and a fee of one-fourth of the amount recovered in such action shall be allowed to the prosecuting attorney bringing the action, and one-fourth shall be paid to the gas inspector; the remaining half of the recovery shall be turned into the general road fund of the county where collected, to be used on the roads, bridges or highways of said county, in the discretion of the county court.

An Act To Conserve Natural Gas Resources of the State of Arkansas.

(Act 144, General Assembly, 1921.)

Section 1. In order to determine the open flow volume of gas produced by any well, it shall be the duty of the State Gas Inspector or his duly authorized deputy to test all wells producing gas in the State of Arkansas, from which gas is being used or marketed, between the 1st day of December and the 1st day of January in each year, and as often thereafter as in his judgment it may be necessary for the purpose of determining the open flow volume and rock pressure of said wells. The State Oil and Gas Inspector shall be paid a fee of $25.00 a day and his actual expenses by the person, firm or corporation whose wells are tested by him or his deputy under the provisions of this section.

Section 2. In determining the open flow volume and rock pressure of said well, said Gas Inspector shall first close the well for a period of five minutes, and then take a test, to determine its closed-in pressure. He shall then immediately open said well and flow it for five minutes, and then take a test of its open flow volume, with approved instruments and devices in use for that purpose.

Section 3. Immediately after the said tests are made, the Gas Inspector shall furnish the person, firm or corporation owning or operating said

well or wells with a copy of the tests made by him, showing the amount of gas which said owner or operator may take from each of said wells daily, and shall file his report of said tests with the county clerk of the county in which said well or wells are situated, showing the closed-in rock pressure and open flow volume, size of the tubing with which said well or wells are closed in, and the condition of the well or wells at the time the test was made; said report to be verified by said Gas Inspector and preserved by the County Clerk in the county records.

Section 4. Before making said tests, the Gas Inspector shall give five days' notice in writing to the person, firm or corporation owning, operating or controlling said gas well or wells, of the time when said tests will be made, and the person, firm or corporation owning, operating or controlling said well or wells, or any other person interested therein, shall have the right to be present when said test is being made, and shall afford to said Gas Inspector every means and facility possible for the purpose of making an accurate test of said well or wells, as provided in this Act.

Section 5. If, in the judgment of the Gas Inspector, it shall be deemed advisable or necessary to test said wells oftener then set out in Section 1, he shall have the right to do so, and for the purpose of making said tests and determining the amount of gas taken therefrom, he shall have access to all wells and to all well records, and all companies, contractors, drillers, lessees or owners of the land upon which said well or wells are located shall permit said Gas Inspector or his deputy to come upon any lease or property owned or controlled by them, and to inspect any and all wells and the records of said wells, and to have access at all times to all wells and to any and all records of said wells used, owned or operated by any person, firm or corporation or the lessees or owners of the land upon which said wells are located.

Section 6. Uniform rules of procedure shall be followed by said Gas Inspector in making the tests hereinabove set out, so that all wells tested by him under this Act shall be upon the said basis and under like conditions, to the end that all wells shall show accurately their rock pressure and volume as closed in at the time said tests are made, and shall be tested under similar conditions.

Section 7. In addition to the annual test provided for in Section 1, it shall be the duty of the Gas Inspector, within ten days after the gas from any well is being used or marketed, to make a test of said wells, as provided for in Section 2, and to make out and file his report of said test with the County Clerk of the county in which said well is located, as provided in said Section 2.

Section 8. When the gas from any well is being used, the flow of production thereof shall be restrained to twenty per cent of the potential capacity of said well; that is to say, in any day of twenty-four hours, the well shall not be permitted to flow or produce more than twenty per cent. of the open flow capacity of said well, as shown by the last test of said well made by the Gas Inspector.

Provided that whenever the rock pressure of any well, when tested as provided in Section 2, is reduced to one hundred pounds, by putting gas into the pipe line under its own volition or pressure, the provisions of this Section shall not apply.

Section 9. All gas produced from gas wells drilled in this State, when sold or used from said well, shall be accurately metered through proper devices, in order to determine the amount of gas taken from said well, which said meters shall be read at least once in every forty-eight hours, for the purpose of determining the amount of gas taken from each well, and such meter readings shall be subject to the examination of the Gas Inspector or any other person interested, for the purpose of determining whether or not the amount of gas being taken from said well is in excess of twenty per cent of the daily open flow of the well as shown by the last test made of said well by the Gas Inspector, provided that when the rock pressure of any well falls below one hundred, this section shall not apply.

Section 10. All oil or gas sands, even though unproductive of oil or gas in the well being drilled, if known to produce oil or gas in any field, shall be protected by judding off such known oil or gas sand by the use of

mudladen fluid, or any other effective method, in the discretion of the Gas Inspector.

Section 11. Whenever a packer or tubing used to shut in the gas in any well does not effectively shut off the oil, gas or water in the strata in which they occurred, said well shall be filled outside of the tubing from the packer to the next producing sand with mudladen fluid of a maximum density of at least twenty-five per cent and the well shall be equipped with what is commonly known as a Braden Head or any other device that will prevent the escape of gas provided that if the next producing sand is not profitable, then it may be filled as above provided to the top, at the discretion of the Gas Inspector.

Section 12. Before any person, firm, corporation or contractor shall commence to drill a well for gas or oil, a separate slush-pit or slump-hole shall be constructed by the owner, operator or contractor, for reception of all pumpings or sand-balings taken from the well, in order to have the same on hand for the purpose of making mud-laden fluid to be used as provided in Sections 10 and 11.

Section 13. Any person, firm or corporation violating any of the provisions of Sections 8, 9, 10 and 11 of this Act shall be subject to a penalty of not less than One Hundred Dollars nor more than One Thousand Dollars for the first conviction for violating the provisions of said sections, and for the second conviction, to a penalty of not less than Two Hundred Dollars nor more than One Thousand Dollars—and for the third conviction, to a penalty of not less than Five Hundred Dollars or imprisonment in the county jail for not less than thirty days, or both such penalty and imprisonment.

The penalties provided for herein to be recovered in an action therefor, brought by the Prosecuting Attorney in the name of the State, together with a reasonable attorney's fee for the Prosecuting Attorney to be fixed by the court, and recovered in the same manner and in the same action.

The proceeds of penalties collected shall be turned in to the General Road fund of the county wherein occurred, to be used on the roads, bridges and highways of said county, in the discretion of the County Court, and the attorney's fee shall be paid over to such prosecuting attorney.

Section 14. This Act being necessary for the immediate preservation of the public peace, health and safety, shall take effect and be in force and effect from and after its passage.

Right of Eminent Domain to Pipe Line Companies

(Act 239—Acts of General Assembly, 1921.)

Section 1. That all pipe line companies operating in this state are hereby given the right of eminent domain and are declared common carriers, except pipe lines operated for conveying natural gas for public utility service. All gas lines or companies operating within the state who render a domestic or general service to the public in furnishing and sale of gas are hereby required to buy or furnish from the lowest or most advantageous market. Failure to do so shall deprive them of the difference in price between such market and the one of which purchases are made.

Section 2. That the procedure to be followed in the exercise of the right shall be the same as prescribed in Section 3992-4003 of Crawford & Moses' Digest relating to railroad companies, telegraph companies and telephone companies.

(Digest of Arkansas Statutes, 1921.)

Section 3969. **Pipe lines—right of way.** Any corporation organized by virtue of the laws of this state, for the purpose of developing and producing mineral oil, or petroleum, or natural gas in this state, and marketing the same, or transporting or conveying the same by means of pipes from the point of production to any other point, either to refine or to market such oil, or to conduct such gas to any point or points to be used for heat or lights, may construct, operate and maintain a line or lines of pipes for that purpose along and under the public highways and the streets of cities and towns, or across and under the waters and over any lands of the state and

on the lands of individuals, and along, under, or parallel with the rights-of-way of railroads, and the turnpikes of this state; provided, that the ordinary use of such highways, turnpikes and railroad rights-of-way be not obstructed thereby, or the navigation of any waters impeded, and that just compensation be paid to the owners of such lands, railroad rights-of-way, or turnpike, by reason of the occupation of such lands, railroad rights-of-way, or turnpikes by said pipe line or lines.

Section 3970. **Procedure...** In the event any such company shall fail upon application to individuals, railroads, or turnpike companies to secure such right-of-way by consent, contract, or agreement, then such corporation shall have the right to proceed to procure the condemnation of such property, lands, rights, privileges, and easements in the manner now provided by law for taking private property for rights-of-way for railroads as provided by Sections 3992-4002, inclusive.

Section 3971. **Right to enter and survey.** Whenever any such corporation shall desire to construct such pipe line or lines upon or under the lands of individuals, or right-of-way of any railroad, or any turnpike, said corporation, by its agents, shall have the right to enter peacefully upon said lands or rights-of-way and survey, locate and lay out its said pipe lines thereon, being liable, however, for any damage that may result by reason of such acts, and shall designate on a plat or map to be made and filed with the county clerk of the county, the width of the strip of land needed to be condemned for its purposes, its location and the depth to which such pipes are to be laid.

Section 3972. **Injury to pipes—penalty.** Any person or persons who shall injure or molest any such pipe or pipes so used for the transportation of such oil or gas shall be guilty of a misdemeanor, and on conviction be fined in any sum not to exceed two hundred dollars; but, should such injury be done wilfully, and be of such a character as to cause such pipes to be so damaged that such oil or gas shall escape and cause damage, either to the company or individuals, or other corporations, then such person or persons shall be guilty of felony, and on conviction thereof, shall be fined not to exceed one thousand dollars and confined in the penitentiary not more than five years.

Taxation of Pipe Lines

Section 9976. Any person or corporation, wherever organized or incorporated, engaged in the business of transmitting oil and gas in pipe lines through or in this state; or owning pipe or pipe lines for such purposes in this state, shall be deemed to be a pipe line company. Such companies shall be assessed for taxation by the Arkansas Tax Commission.

Section 9977. It is made the duty of every * * * pipe line company, wherever organized or incorporated, and carrying on a business in this state, on the first Monday in July, any year, to make out and file with the Arkansas Tax Commission a statement showing in detail the following.

1. A copy of the articles of incorporation, under which the company is organized and carrying on business; said copy to be filed but once unless the Commission should otherwise direct;

2 The amount of capital stock subscribed, whether designated as common or preferred, or by any other description, showing the par value of each share and the market value thereof on the first Monday in June of said year;

3 The face value of all bonds, secured by mortgages on the company's property, outstanding and the market or actual value of such bonds:

4 The total number of miles of pipe lines owned or operated within and without this state by any such pipe line company in the transaction of its business.

Section 1806. Foreign pipe line companies doing intrastate business are required to pay the same fees as are prescribed for such corporations organized under the laws of this state.

For Protection of Pipe Lines

(Digest of the Statutes of Arkansas, 1921)

Section 2480. **Setting fire to escaping gas.** It is hereby declared to be unlawful for any person or persons to set on fire any gas escaping from wells or from broken or leaking mains, pipes, valves, or other appliances, used by any person, company or corporation in conveying gas to consumers, or to tap any pipe or main for the purpose of taking and stealing gas therefrom, or to interfere in any manner with wells, pipes, mains, gate boxes, valves, stopcocks or other appliances, machinery or other property of any person, company or corporation engaged in furnishing gas to consumers, unless employed by, and acting under the authority and direction of such person, company or corporation furnishing gas to consumers.

Section 2481. **Extension of gas pipe without permission.** It is hereby declared unlawful for any person, in any manner whatever, to change, extend or alter, or cause to be changed, extended or altered, any service or other pipe or attachment of any kind, by or through which natural or artificial gas is furnished from the gas mains, or pipes of any person, company or corporation without first securing * * * written permission to make such change, extension or alteration.

Requiring Release of Forfeited Leases

(Act 192, General Assembly, 1921)

Section 1. It shall be the duty of every person holding an oil, gas or other mineral lease for prospecting and exploiting for oil, gas or other minerals, upon any real estate in the State of Arkansas, upon forfeiting the right to further prospecting on such lands, by failure to pay any rental, or to perform any condition imposed on the lessee, or otherwise forfeiting such rights under said lease, upon notice hereinafter prescribed by the lessor, to execute a release to the grantor, or otherwise remove any cloud or incumbrance on the title to such lands by reason of any such forfeited lease.

Section 2. Any owner of lands upon which a lease for the development of oil or gas, or other minerals, has been given and the lessee forfeits his rights at any time to further prospect for such minerals upon said lands, by reason of a failure to pay periodical rentals or to perform other conditions that nullify the lease as to lessee's rights therein (may give) written notice, served in the manner of a legal summons upon the lessee demanding that said lessee execute and place on record a release which in effect will remove any cloud existing upon the title of such lands; upon failure of said lessee to comply with said notice he shall be liable to the lessor or owner of said lands in damages in whatever sum the owner of such lands may sustain by reason of said cloud or incumbrance upon said lands after thirty days from the service of said notice.

Guardians of Wards May Release Mineral Rights.

(Act 174, General Assembly, 1921)

When it shall appear that it would be for the benefit of the ward, that his or her lands, or any part thereof, be leased for the production of oil, gas, coal, zinc, lead, copper or other minerals or metals therefrom, his or her guardian, or curator, may lease the same upon obtaining an order from the court of probate of the county in which such lands or the greater part thereof shall be situated.

(Digest of the Statutes of Arkansas, 1921)

Section 5872. When a non-resident lunatic or person of unsound mind, incapable of conducting his own affairs, owns real property in this State and has a guardian or curator in the State where he resides, the court of probate of the county where such lands or the greater part thereof are (is) situated may authorize such guardian or curator to lease said lands or any part thereof for the production of oil or gas upon securing an order from the probate court and complying with the terms and provisions of this act.

Synopsis of Oil and Gas Inspection Laws.

(Digest Statutes of Arkansas, 1921)

Section 5900. Creates office of inspector of the petroleum oils kerosene and gasoline, etc.; offered for sale or sold for illumination, heating power purposes in Arkansas, for a period of 30 years; to be appointed by the governor; inspector shall be a resident of the State and shall be appointed for a term of four years; he shall give a bond in the sum of $25,000. Said inspector with the approval of the governor shall appoint not to exceed six deputies whose salaries shall not exceed $100 a month; these inspectors to be located at convenient places within the State; provides office clerk at salary not to exceed $1200 a year; salary of inspector fixed at $3000 a year; deputy inspectors have powers and duties and are subject to the same penalties as the inspector; bonds required of deputies; deputies shall make report to the inspector on the first and sixteenth of each month; showing in detail all the inspections made, the stamps and certificates on hand, received and issued.

Section 5901. Duty of owner, manufacturer, wholesale dealer or jobber, in any of the oils or fluids to inspect the same or cause the same to be inspected in any quantities, from one barrel to car tank, before the said oils or fluids are sold, and shall at the time of making the inspection thereof attach to the car, can, cask or barrel or other vessel containing said oils, a stamp or stamps sufficient in amount to show the payment of all fees required by this article; stamps to be cancelled; unlawful to use cancelled stamps; each vessel shall also bear a certificate stating that the contents have been inspected. The fire test of all petroleums or kerosene oils for illuminating purposes shall be equal to a test prescribed in the succeeding section.

Section 5902. Inspector shall use Taglibue's or other similar instruments; methods of making tests defined in detail.

Section 5903. None of the substances which ignite or burn at any temperature less than 150 degrees F. shall be offered for sale or use; provided however, that it shall be lawful to sell any of the fluids in the form of vapor or gas, regardless of the degree of the fire test.

Section 5904. Provides methods of testing gasoline oils.

Section 5905. Inspectors and deputies shall make oath.

Section 5906. Fees for inspection; for each barrel or smaller article, 12 cents; in bulk one-eighth of a cent per gallon.

Section 5907. Inspector authorized to rent suitable offices for deputies wherever located.

Section 5908. Duty of persons bringing oil into the State to provide inspection before oil is offered for sale and pay the inspection fee by means of stamps; inspector or deputy, when called upon, shall as soon as practicable make inspection.

Section 5909. Inspector or deputy have power to make inspection and test of any oils wherever found, right to administer oaths and to inspect any and all records having reference to the receiving, forwarding or transportation of any such oils or gasolines; duty to prosecute violations.

Section 5910. State Treasurer shall provide suitable and inimitable certificates and stamps, in proper form, and upon application deliver them to the inspector or deputy in quantities necessary to meet the demands, taking a receipt and charging same to the official receiving them; and the State Treasurer from time to time, as said inspectors make returns shall cerdit their accounts and keep a true and correct record of the dealings. The stamps shall be made in denominations, as required, but not less than 12 cents and not more than $12, each series to be progressively numbered.

Section 5911. Inspectors and deputies may be removed for neglect of duty and held on their bonds for an adjustment of these stamp accounts; also liable under criminal law.

Section 5912. No inspector or deputy shall, while in office be interested directly or indirectly in the manufacture or sale of oils or gasoline, nor shall he for the purpose of inspection, take away for his own use or the use of others, any part or portion of said oils.

Section 5913. Inspectors and deputies shall keep a correct record of all oils and fluids inspected and of all stamps, certificates and other property coming into his hands, and this record shall be open to public inspection; detailed reports to be made annually to the Governor; all money collected as inspection fees shall be remitted once each month to the State Treasurer.

Section 5914. Governor shall fill vacancy in office of inspector; inspectors to fill vacancies in offices of deputies but the term of no deputy shall extend beyond that of the inspector.

Section 5915. Penalty for persons, firms or corporations who fail to comply with the provisions of this act.

Section 5916. When shipments of oil are received the dealer shall at once notify the chief inspector or one of his deputies of the quantity and request inspection. If for any reason a prompt inspection is impossible the dealer or his agent may subject said products to the test prescribed in this act and on furnishing the inspector or his deputy an affidavit that said oils have met the requirements of the test, he shall be entitled to receive stamps showing the inspection has been made, and when said stamp is placed on the vessel and cancelled, the oil or gasoline may be sold the same as if it had been inspected by the oil inspector or his deputy.

Section 5917. Auditor authorized to issue warrants from the fund created by the fees paid into the treasury under the provisions of this act, for the payment of salaries and expenses; only expenses allowed, in addition to office expenses, shall be those necessarily incurred for making inspections at places other than where the inspector or deputies shall be located.

Section 5918. Duty of railroads or their agents at place of destination, to notify State Inspector of arrival and delivery of all car tanks containing any of the fluids mentioned in this article for inspection, giving the number, initial and capacity of such car; penalty for non-compliance.

Synopsis of Arkansas Blue Sky Law

(FROM ACT 242, GENERAL ASSEMBLY, 1915—AND AMENDMENTS.)

AN ACT to prevent fraud in the sale and disposition of contracts, stocks, bonds, or other securities sold or offered for sale within the State of Arkansas by any dealer, firm, company, association or corporation, foreign or domestic, by requiring an inspection of such contracts, stocks, bonds, or other securities and an inspection of the business of such persons, firms, companies, associations or corporations, including dealers and agents, and such regulation and supervision of the business of said persons, firms, companies, associations or corporations, including dealers and agents as may be necessary to prevent fraud in the sale within this State of any contracts, stocks, bonds, or other securities, and to provide a penalty for the violation thereof.

Bank Commissioner Executive Officer.

Section 1. State Bank Commissioner delegated with full power to supervise and enforce the provisions of Act and make such rules and regulations as may be necessary.

Investment Company Defined.

Section 2. Every person, corporation, co-partnership, company or association (except those elsewhere exempted), which shall sell or negotiate for the sale of any contract, stock, bonds or other securities, within the State, shall be known for the purpose of this Act as a domestic investment company; if a resident of or organized in any other state, they shall be known as a foreign investment company.

Exempts Certain Classes of Securities.

Section 3. Provisions shall not apply to securities of the United States, or any foreign government; or any state or territory thereof, or of any county, city, township, district, or other public taxing subdivisions of any state or territory of the United States, or any foreign government; unsecured commercial paper; securities of a public or quasi-public corporations, the issue of which is regulated by the Arkansas Railroad Commission

or by any public service commission or board of legal authority of any state or territory of the United States or securities senior thereto; securities of State or National banks or trust companies; securities of any domestic corporation organized without capital stock, and not for pecuniary gain, or exclusively for educational, benevolent, charitable, or reformatory purposes; mortgages upon real or personal property situated in this state where the entire mortgage is sold and transferred with the note or notes secured by such mortgage; increase of stock sold and issued to stockholders, also stock dividends, securities which are listed in any standard manual of information approved by the said Bank Commissioner; provided, however that said Bank Commissioner shall have power to call for additional and further information that contained in such manuals with reference to any securities listed therein; and may, pending the filing of such information, suspend the sale of such securities, and also suspend, either temporarily or permanently, the sale of any securities listed in such manuals after a hearing upon notice to the issuer of such securities of said Bank Commissioner shall find that the sale of such securities would work a fraud upon the purchaser thereof.

Methods of Applications and Fees.

Section 4. Before selling, offering for sale, taking subscriptions for, or negotiating for the sale in any manner whatsoever in the state, any contracts, stocks, bonds or other securities of its own issue, every investment company, domestic or foreign, shall file in the office of the Bank Commissioner a statement showing in full detail the plan upon which it proposes to transact business, a copy of all contracts, stocks, bonds, or other instruments which it proposes to make with or sell to, its contributors or customers, together with a copy of its prospectus, and of the proposed advertisements of its sale of stocks, bonds or other securities, with name and location of main office, name and addresses of its officers, and an itemized account of its financial condition and of its assets and liabilities, and such other information as the Bank Commissioner may require. If a co-partnership or unincorporated association, such investment company shall also file a copy of its articles of co-partnership or association and all other papers pertaining to its organization. If a corporation organized under the laws of Arkansas, it shall also file a copy of its articles of incorporation, constitution and by-laws and all other papers pertaining to its organization. If organized under the laws of any other state, territory or government, incorporated or unincorporated, it shall also file a copy of the laws under which it exists, and also a copy of its charter and the certificate showing that it is authorized to transact business there; and also copies of its constitution and by-laws of all amendments of any of the above mentioned instruments which have been made, and of all other papers pertaining to its organization. It shall also pay a filing fee of one-tenth per cent upon the face value of the securities for the sale of which application is made; provided such filing fee shall not be more than $100, nor less than $10.

Section 5 Papers shall be verified by oath.

Consent For Service of Process.

Section 6 Every foreign corporation before offering for sale any of its stocks, bonds, or other securities shall file its irrevocable written consent that suits and actions may be commenced against it in the proper courts of any county in this state in which a cause of action may arise, or in which the plaintiff may reside, by the service of any process of pleading authorized by the laws of this state.

May Require Additional Information.

Section 7. The said Bank Commissioner shall have power to demand from any investment company seeking to come under the provisions of this act any further information necessary to qualify him to pass upon all questions that may come before him. He may make an examination of the company's property, business and affairs, at the expense of the applicant; he may cause an appraisal to be made at the expense of the in-

vestment company, of the property, including the value of patents, good will, promotion and intangible assets, and he may fix the amount of stocks, bonds, or other securities that may be issued by any corporation in payment for property, patents, good will, promotion and intangible assets at the value he shall find same to be worth and may require that such stocks, bonds or other securities so issued for such property, etc., shall be deposited in escrow under such terms as he may prescribe. And said Bank Commissioner may withhold his certificate of authority to sell such stocks, bonds or other securities if such corporation has issued stocks, etc., for such purpose in excess of their value as found by said Bank Commissioner, or if such stocks, bonds or other securities are not deposited in escrow according to the terms fixed by the Bank Commissioner, until such stocks, bonds or other securities issued in payment for property, patents, good will, promotion and intangible assets in excess of the value so found by said Bank Commissioner has been surrendered to such corporation and canceled by it, and until the said stock has been deposited in escrow under the terms prescribed by said Bank Commissioner.

Shall Issue Permit, if Found Not Fraudulent.

Section 8. It shall be the duty of said Bank Commissioner to examine the statements and documents filed in his office by any investment company and the reports of any investigation conducted under the direction of said Bank Commissioner and to hear such applicant and he shall have power to examine under oath any person interested or connected with such investment company, and if he finds that the proposed contracts, stocks, bonds or other securities are fraudulent or of such nature that the sale thereof would work a fraud upon the purchaser, then the said Bank Commissioner shall disapprove the sale of such proposed contracts, etc., and shall notify such investment company by registered mail of his findings, and it shall be unlawful for such company to do any further business in the way of selling, offering for sale in any manner whatever of any such contracts, stocks, bonds or other securities in this state. If, however, such Bank Commissioner shall not find that the proposed, plan of business, contracts, etc., are fraudulent or are of such nature that the sale thereof would, in the opinion of said Bank Commissioner work a fraud upon the purchaser thereof, then he shall approve the sale of same in the State of Arkansas and issue his certificate in substantially the following language:

"This is to certify that the ———— has this day been given permission to sell $———— of its (stocks, bonds or other securities) within the State of Arkansas. THE BANK COMMISSIONER DOES NOT RECOMMEND THE PURCHASE OF THIS SECURITY. This ———— day of———— A. D. 192——. In witness whereof I have hereunto affixed the seal of the Bank Department. Done at Little Rock this ———— day of ———— A. D. 192——.

(Seal) Bank Commissioner."

The words, "The Bank Commissioner does not recommend the purchase of this security," shall be printed in type two sizes larger than any other part of said certificate in which style the certificate must appear if used in connection with any advertising matter.

Dealer Defined; Regulations Prescribed.

Section 9. Any person, firm, co-partnership, corporation or association, whether domestic or foreign, not the issuer, who shall in this state sell or offer for sale any of the stocks, bonds or other securities issued by any foreign or domestic investment company except the securities specificaally exempted in this Act, or who shall, by advertisement or otherwise, profess or engage in the business of selling or offering for sale such securities, shall be deemed to be a dealer, and no dealer shall sell or offer for sale any such securities or profess the business of selling or offering for sale such securities unless and until he shall have filed a list of the same in the office of the Bank Commissioner. The term dealer shall not include an owner, nor issuer, of such securities so owned by him when such sale is not made

in the course of continued and successive transactions of a similar nature, nor one who, in a trust capacity created by law, lawfully sells any securities within such trust.

How Dealer May Be Licensed.

Section 10. Dealer must first register with the Bank Commissioner and furnish upon oath the following information: Name, residence and business address; general character of securities; the place where business is to be conducted within this state and the names and addresses of all persons in charge thereof. Said dealer shall pay an inspection fee of $50. All authorized agents of any dealer shall be registered. The name of any agent shall be stricken from the register upon written request of the dealer and additional agents may be registered upon request accompanied with the fee therefor, provided, that no agent shall act as such until registered.

If the dealer be a foreign corporation, it shall at the time it registers file a written, duly authenticated appointment of the Bank Commissioner of this State as its agent in Arkansas upon whom process or pleadings may be served for and on behalf of the dealer for the purposes mentioned in Section 6 and such appointment shall be irrevocable.

Upon compliance by such dealer with the provisions of this act the said Bank Commissioner shall issue to him a certificate of authority which shall be valid for one year, or until revoked for good cause upon notice to such dealer as a hearing duly had. If not revoked before the expiration of one year such certificate may be renewed upon receipt of one inspection fee of $25.

Registration of Agents.

Section 11. In addition to the filing fees and the examination fees there shall be charged a fee of $2 for the registration and authorization of each agent of any such dealer or investment company, and shall be valid until March 1, following unless sooner revoked. Fees to be paid into the State Treasury and applied toward the payment of the expenses of enforcing this Act. The expenses of said Bank Commissioner shall not, however, be limited to the money received by him, but he shall have power to incur all expenses he finds necessary in enforcing the provisions hereof.

Accounts and Examinations—Fees.

Section 12. The general accounts of every investment company shall be kept in a business-like and intelligent manner, and in sufficient detail that said Bank Commissioner can ascertain at any time is financial condition and the books of accounts shall at all times during business hours be open to stockholders and investors in said company, or the said Bank Commissioner, and all such investment companies shall be subject to examination at any time in the same manner as is now provided for the examination of State Banks, and such investment companies other than building and loan, building, or building and savings associations shall pay a fee for each such examination not to exceed $10 per day or fraction thereof that any examiner is absent from the capitol building for the purpose of making such examination, and in addition thereto shall pay the actual hotel and traveling expenses of such authorized examiner from Little Rock and return.

The Bank Commissioner shall make at least once a year an examination of all building and loan, building ,or building and savings, associations doing business in this state in the manner now provided for state banks, and such associations shall pay a fee of not to exceed $10 per day plus 10 cents per each one thousand dollars or fraction thereof of its assets, provided, that in no event the charge for such examination exceed $50, if a domestic investment company, and that such charge may not exceed $50 plus the necessary hotel and traveling expenses from Little Rock and return if such association be a foreign corporation. Failure to pay such fees shall work a forfeiture of the right of such investment company to sell or offer for sale any of its stocks, bonds or other securities in this State. The same fees are provided for the preliminary examination of any

investment company to ascertain whether it shall be permitted to come under the provisions of this act. If the Bank Commissioner finds that the further sale of stocks, etc., would work a fraud upon the purchaser he may revoke the license of such company upon notice duly given and a hearing duly had and may, pending such hearing, suspend the right of such company to sell its securities.

Unlawful to Do Any Business Until Law Is Complied With.

Section 13. It shall be unlawful for any investment company or dealer or representative thereof, either directly or indirectly, to sell or cause to be sold, offer for sale, take subscriptions for, or negotiate for sale in any manner in this state any contracts, stocks, bonds or other securities (except as expressly exempted herein) unless and until said Bank Commissioner has approved thereof and issued his certificate in accordance with the provisions of this Act, nor shall it be lawful for any such investment company to transact business on any other plan other than that set forth in the statement and papers required to be filed by virtue of the provisions of the Act or the rules of the Bank Commissioner.

Unlawful for any investment company to circulate any advertisement in regard to its stocks differing in any way from the copy filed with the Bank Commissioner, and unlawful for any newspaper to advertise the sale of securities not approved by said Bank Commissioner, or which are not exempt under the provisions of this Act.

Dealer Shall Not Sell Securities Until Law Is Complied With.

Section 14. No dealer shall sell any securities unless such investment companies have fully complied with the provisions of this Act, nor until said dealer shall have registered, provided, that should any dealer desire to sell the securities of any investment company which has not itself complied with the provisions of this Act, said dealer shall make application for license as hereinbefore provided for applications by investment companies and shall pay the same fee required to be paid by said investment companies.

Information Subject to Public Inspection.

Section 15. All information obtained by the Bank Commissioner with reference to any securities and all records of the Bank Commissioner relating thereto shall be open to examination by the public and it shall be the duty of the Bank Commissioner to preserve such information and so classify and arrange it as to facilitate examination and inspection thereof. The Bank Commissioner may publish information regarding any and all contracts, stocks, bonds or other securities sold or offered for sale in this state which he deems would be of public interest or advantage.

Does Not Repeal Bank or Insurance Laws.

Section 16. Nothing in this Act repeals or nullifies any law giving the State Bank Department control over State banks or the Insurance Commissioner control over the business of insurance in this state and those engaged therein.

Penalty For False Oath.

Section 17. Any person who shall make or cause to be made a false statement or false entry in any book of any investment company, or who shall exhibit any false paper for the purpose of deceiving any person authorized to examine into the affairs of said investment company, or shall make or publish any false statement of the financial condition of said investment company or false statement relating to the contracts, stocks, bonds or other securities shall be deemed guilty of a misdemeanor and shall be punished as hereinafter provided.

Copy of Records May Be Furnished.

Section 18. The Bank Commissioner shall provide for the furnishing of those who may apply therefor of any information regarding any investment company or its affairs, which is on file in its office, and charge there-

for approximately the cost of preparing such information and 50 cents for each certificate of authentication, fees to be paid into the State Treasury for the expense of carrying this Act into effect.

Annual Reports Required.

Section 19. Every investment company shall file during the months of January and July each year a detailed statement in such form and containing such information as the Bank Commissioner may prescribe, showing its condition at the close of business December 31 and June 30, preceding and shall at the same time pay a filing fee therefor of $2.50, provided that said Bank Commissioner may call for other or additional reports of any kind at any time and such other or additional reports shall be filed within 20 days. Building and loan associations shall file only an annual statement as of December 31.

Penalty For Not Filing Reports.

Section 20. Companies failing to file reports shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not to exceed $1,000 and in addition thereto their authority to do business in Arkansas may be canceled.

Appeal To Chancery Court.

Section 21. An appeal will always lie to the Chancery Court, upon petition of any person aggrieved and upon payment of the costs of preparing such copies of papers and other documents desired by said petitioner from any final orders of the Bank Commissioner. The granting of an appeal shall not, however, unless so ordered by the court, operate as a stay of proceedings.

General Penalty Prescribed.

Section 22. Any persons who shall violate any of the provisions of this Act shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not more than $1,000, or may be imprisoned in the county jail for not more than one year, or by both such fine and imprisonment.

Constitutionality Confined To Each Section.

Section 23. Should the courts of this state or of the United States declare any section or provision of this Act unconstitutional or unauthorized, or in conflict with any other section or provision of this Act, then such declaration shall affect only the section or provision so declared to be unconstitutional or unauthorized, or if in conflict only such provisions or parts as are so held, and such holding shall not affect any other section or part of this Act.

Repeals Laws In Conflict.

Section 24. All laws and parts of laws in conflict herewith, and particularly Act 214 of the Legislature of 1913, in its entirety are hereby repealed, and this Act being necessary for the immediate preservation of the public peace, health and safety, shall be in force from and after its passage.

Approved March 24, 1915.

Amendments to Sections 19 and 20 approved March 26, 1921.

List of Arkansas Geological Survey Publications

FIRST REPORT, 1857-1858.

Geological Reconnaissance of the Northern Counties of Arkansas, by D. D. Owen.

SECOND REPORT, 1859-1860.

Geological Reconnaissance of the Northern Counties of Arkansas, by D. D. Owens.

ANNUAL REPORT, 1871-1872.

Geological Reconnaissance of a part of the State of Arkansas by George Haddock.

ANNUAL REPORT FOR 1888

Vol. I—Gold and Silver, by Theo. B. Comstock, Pp. xxxi, 320, 2 maps.

Vol. II—Mesozoic, by R. T. Hill. Pp. xiv, 319; illustrated; 1 map.

*Vol III—Coal (preliminary), by Arthur Winslow, Pp. x, 120; illustrated; 1 map.

*Vol IV—Washington County, by F. W. Simonds; Plant List, by J. C. Branner and F. V. Coville. Pp. xiv, 262; illustrated; 1 map.

ANNUAL REPORT FOR 1889

Vol. I—Clays, Kaolins and Bauxites. Illustrated; maps. By J. C. Branner; illustrated, about 300 pages. (Not published).

Vol. II—Crowley's Ridge, by R. E. Call. Pp. xix, 283; illustrated; 2 maps.

ANNUAL REPORT FOR 1890

Vol. I—Manganese, by R. A. F. Penrose, Jr. Pp. xxvii, 642; illustrated; 3 maps.

Vol. II—Igneous Rocks, by J. Francis Williams. Pp. xv. 457; illustrated; 6 maps.

Vol III—Novaculties, by L. S. Griswold. Pp. xx, 443; illustrated; 2 maps.

Vol. IV—Marbles, by T. C. Hopkins. Pp. xxiv, 443; illustrated; atlas of 6 maps.

ANNUAL REPORT FOR 1891

*Vol. I—Mineral Waters, by J. C. Branner. Pp. viii, 144; 1 map.

*Vol. II—Miscellaneous Reports:—Benton County, by F. W. Simonds and T. C. Hopkins; Elevations, by J. C. Branner; River Observations, by J. C. Branner; Magnetic Observations, by J. C. Branner; Mollusca, by F. A. Sampson; Myriapoda, by Charles H. Bollman; Fishes, by Seth E. Meek; Dallas County, by C. E. Siebenthal; Bibliography of the Geology of Arkansas, by J. C. Branner. Pp. x, 349; illustrated; 2 maps.

ANNUAL REPORT FOR 1892

*Vol. I—Iron Deposits, by R. A. F. Penrose, Jr. Pp. x, 153; 1 map.

Vol. II—Tertiary, by Gilbert D. Harris. Pp. xiv, 207; illustrated, 1 map.

Vol. III—Coal, final report; illustrated; topographic maps and sections. By Arthur Winslow and others. (Not published).

Vol. IV—Lower Coal Measures; topographic maps, sections and illustrations, by J. H. Means and Geo. H. Ashley. (Not published).

*Vol. V—The Zinc and Lead Deposits, by J. C. Branner. Pp. xiv, 395; illustrated; atlas of 7 maps.

Relief maps of the State, of the Coal Area and of Magnet Cove were also made under the Branner survey.

REPORT OF 1909

*The Slates of Arkansas, by A. H. Purdue, State Geologist, with a Bibliography of the Geology of Arkansas by John C. Branner, former State Geologist.

REPORT OF 1910

Coal Mining in Arkansas, Part I, by A. A. Steel, professor of mining, University of Arkansas.

REPORT OF 1911

*Water Powers of Arkansas, a Preliminary Report on White River and some of its tributaries,, by W. N. Gladson, engineer in charge of Water Power Investigations.

LATER PUBLICATIONS

Outlines of Arkansas Geology, Soils and Minerals of the State of Arkansas, by Jim G. Ferguson, Commissioner of Mines, Manufacturers and Agriculture.

*Minerals in Arkansas, by Jim G. Ferguson, Commissioner of Mines, Manufactures and Agriculture.

*Report of a Survey of the El Dorado, Arkansas oil and gas field, by the United States Geological Survey, published by the State Bureau of Mines, Manufactures and Agriculture.

The reports marked with a star may be obtained by forwarding the necessary postage (11cents each) to the State Bureau of Mines, Manufactures and Agriculture, Little Rock, Ark. Reports the titles to which the star is not affixed are out of print and unavailable for distribution but many of them may be found in public and private libraries.

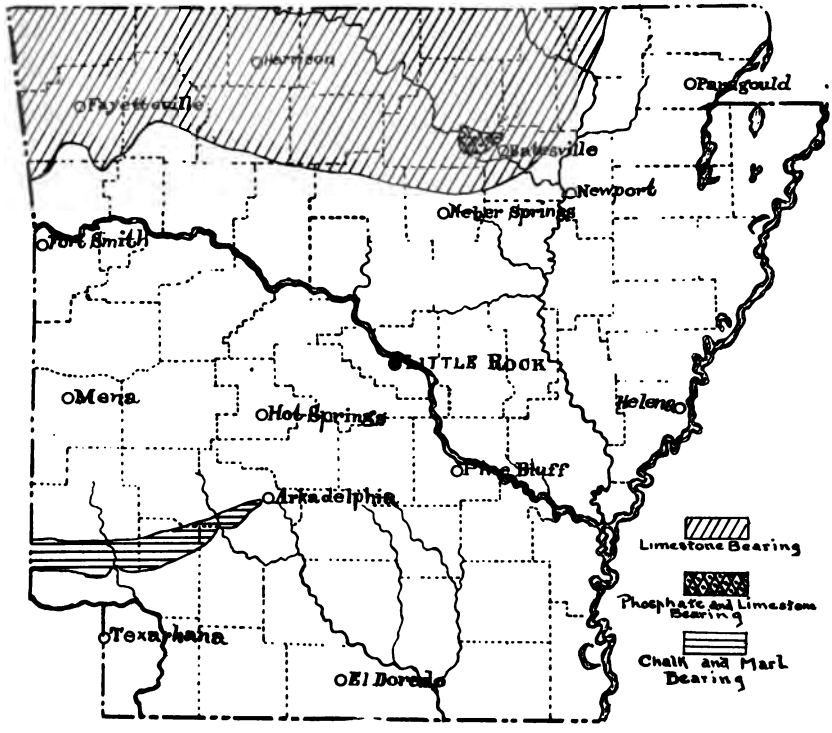
United States Geological Survey Publications on Arkansas

Subject	Reference
Antimony	*Bulletin 340-D
Asphalt, Pike County	*Bulletin 213
Southwestern Part	Bulletin 691-J
Bauxite	*Annual Report 21 III-D
Building Stone, Eureka Springs-Harrison District	Geologic Folio 202
Cement Materials	*Bulletins 243, 522
Chalk, Southwestern Part	*Annual Report 22 III-O
Clays	*Bulletins 285-L, 351
Coal	*Annual Report 21 II-F, 22 III-I
	*Bulletin 316-B, 326
Diamonds	*Bulletin 540-II
	*Mineral Resources 1906-E
Earthquakes	*Bulletin B-494
Fossils, Batesville Sandstone	Bulletin 593
Boone Chert	Bulletin 595
Boone Limestone	Bulletin 598
Eocene	Professional Paper 91
Moorefield Shale	Bulletin 439
Fullers Earth	*Bulletin 530-Q
Gauging Stations	Water Supply Paper 437

Gas, Ft. Smith-Poteau Field ..... *Bulletin 541-B
Geology, Camden Field ..... *Annual Report 21 II-F
Eureka Springs District ..... Geologic Folio 202
Fayetteville District ..... Geologic Folio 119
Ft. Smith-Poteau Field ..... *Bulletin 541-B
Harrison District ..... Geologic Folio 202
Northern part ..... Water Supply Paper, 145, 399
Southern part ..... *Professional Paper 46
Southwestern part ..... Bulletin 691-J
Winslow District ..... *Geologic Folio 154
Gravel Deposits ..... Bulletin 690-B
Greensand ..... Bulletin 660-B
Hot Springs ..... Water Supply Paper 145
Lead, Northern part ..... *Bulletin 213
*Professional Paper 24
Leveling ..... *Annual Report 18-B, 19-B, 20-B, 21-B.
Bulletins *185, *458, 636
Manganese ..... Bulletins 427, 660-C
Mineral Springs ..... *Water Supply Paper 114
Oil, Southwestern part ..... Bulletin 691-J
Peridotite ..... *Bulletin 540-U
Phosphates, Northern part ..... *Bulletin 315-P
Precious Stones ..... Bulletin *540-U
*Mineral Resources 1906-E; 1913 II J
Slates ..... Bulletins *225, *275, *430-F
Springs ..... Water Supply Paper 102, 110, *114, 145
Traverse ..... *Annual Report 21-B; Bulletins *181, 201, 310, 440, 644-H
Triangulation ..... *Annual Report 18-B, 20-B; *Bulletin 181
Water Resources—
Bibliography ..... Water Supply Paper 437
Surface Waters, Gauging Stations ..... Water Supply Paper 437
Quality ..... Water Supply Paper 236
Steam Measurements..Water Supply Paper 131, 173, 209, 267, 287, 307
Underground Waters, Eureka Springs-Harrison
District ..... Geologic Folio 202
Northern part ..... Water Supply Paper 145, 399
Ozark region ..... Water Supply Paper 110, 145
Quality ..... Water Supply Paper 102, 145, 364, 399
Southern part ..... *Professional Paper 46
Southwestern part ..... Bulletin 691-J
Springs ..... Water Supply Paper 102, 110, 114, 145
Wells ..... Water Supply Paper 102, 114, 145, 149, 364
Winslow District ..... Water Supply Paper 145
Zinc, Northern part ..... *Professional Paper 24; Bulletin 213

*Supply exhausted, but copies may be consulted in public libraries. Publications for distribution may be obtained from the U. S. Geological Survey, Washington, D. C.

Soil Building in Progress on an Arkansas Valley Farm



Map Showing Area of Mineral Fertilizers In Arkansas

SOIL AND SOIL-BUILDING MATERIALS IN ARKANSAS

By N. F. DRAKE
Geologist State Bureau of Mines.

Arkansas is primarily an agricultural state. Her farm and forest products are first in value of her resources and those products come from the soil. It is well, therefore, that we give due thought to our soils that the best results may be realized. The following brief discussion of soils is given with the hope that some assistance will be rendered in promoting better usage, tillage, improvement, and preservation of our soils. The following general discussion of the origin, classification, characteristics and ways of improving soils is given with a view of helping to the best usage of our limestones, chalks, phosphates and marls for soil improvement. For this purpose it is thought not worth while for the most part to discuss specifically local types of soil. Discussion of specific features should follow careful field and laboratory work such as is being done by the United States Bureau of Soils. As noted elsewhere in this publication, soil surveys have been made and are being made that now cover a considerable portion of the state.

Origin of soil.—Soil is finely divided rock material mixed with decayed vegetable and animal matter. It is continually being formed from rocks and organic matter by weathering agencies. No matter how hard or what kind of rock it may be, if exposed to weathering agencies it gradually crumbles into soil particles wherever exposed. Changing temperature of a rock surface produces alternate expansion and contraction which strains portions

of the rock to the breaking point. Freezing of water held in the pore spaces of the rock pries off an outer film and in places larger particles of the rock. Rocks are soluble in water in varying proportions according to the kind of rock and the character of the water. Different kinds of minerals enter into the composition of most rocks and these minerals vary in their rate of expansion under changing temperatures and they also differ in their solubility so that when the least stable mineral breaks to pieces or is dissolved and carried away the rest of the rock readily falls to pieces. Plant and animal matter, broken up largely by bacterial action, leaves dark colored particles that enter into the mixture of disintegrated rocks in the forming of soils.

Classification of Soils.—Soil is, for the most part, composed of sand, clay, and humus in varying proportions and these ingredients form the bases of many of the classifications as sandy soil, clayey soil, loamy soil, etc. A popular classification of soils designates them as heavy or light soils, which has no reference to weight, but refers to the ease of tilling. The heavy soils are not easy to till and have a predominance of clay while the light soils till easily and have a predominance of sand or humus or both.

A classification taking into consideration the more minute physical and chemical properties gives such divisions as the following: Gravely, sandy, silty, loamy, humus, calcareous, magnesian, etc. Sandy soils have something like one-half of their particles large enough to be readily seen as individual grains by the unaided eye, while only a very small percent of the individual particles of a clay soil can be readily seen. A loamy soil has particles intermediate in size between the sandy and clayey soils.

Humus soils are those that contain a high percentage of decaying organic matter. A calcareous soil is one in which lime carbonate is a dominant feature of the soil, etc.

A classification that takes into consideration the origin of the soil is often of more value in explaining the nature of the soil. Such a classification is the following:

Residual soil. This is formed from the immediate underlying rocks and is not removed from its place of origin.

Transported soil. This is a soil shifted from its place of origin. As some divisions of the transported soils we have the following: Colluvial soil, a soil formed on sloping ground from disintegrated rocks that lay higher up the slope. Alluvial soil, a soil formed from the sediments dropped from flood waters overflowing stream valleys. Loess soil, a soil carried by air currents and deposited as a manteling over certain localities.

For a minute study local place names are often given to specific types of soils that have a more or less local occurrence. In most any extended discussion of soils terms used in making different kinds of soil classification are needed for a comprehensive discussion.

Texture and character of soil.—Examining the soil from the surface downward we find the topmost part more porous and usually darker in color than lower portions called the subsoil, but both have very fine grains. As we examine deeper and deeper portions we reach material that is not entirely disintegrated and finally we reach unaltered rock. In many places coarse fragments of rock pebbles, and even boulders, are mixed with the fine soil material, but they are not a part of the soil proper though they are materials out of which soil is made. In many soils there are crystalized minerals surrounding and attached to other rock fragments. These crystaline minerals have been deposited from over saturated solutions of soil waters. In clayey soils there is a small quantity of hydrated silica of alumina which, though it may be in minute quantities, gives a sticky, plastic quality to the clay when moist.

SOME PHYSICAL AND CHEMICAL CONDITIONS INFLUENCING PLANT GROWTH

Porosity of soil.—A soil that is open or porous holds more moisture and better allows entrance of the air, which are favorable for plant growth. If the pores are exceedingly small and the soil is compact, capillary action is strong and the soil moisture is more rapidly carried to the surface and evaporated to the detriment of plant growth. Lime tends to floculate clay into larger particles and to cement small particles, making larger grains

thus rendering the soil more open and easier to till. Cultivation also loosens the soil and makes it more porous.

Drainage.—In low lands where drainage is poor the soil is kept so full of water that it is sour because of the formation of organic acids; furthermore such soils do not warm readily in springtime because of so much water and evaporation. Such conditions are unfavorable to most plant growth.

Some of the most important plant foods.—While the most important feature of a soil is that it should be able to hold and give up moisture to plants as needed it is also of prime importance that the soil should contain materials that the plants need to induce proper growth and maturity. Such materials as oxygen, hydrogen, nitrogen, phosphorus, lime, potash, iron, sulphur, and a few others to a lesser extent, are necessary to plant growth.

Oxygen and hydrogen that plants make use of come mainly from water contained in the soil. These elements make up a considerable part of the tissue, starch, and sugar of plant growth.

Nitrogen.—Nitrogen forms a part of the fragments of decaying plants and animals that occur in practically all soils. Microscopic life in the soil converts parts of these fragments into nitric acid, which in turn unites with lime and potash to form soluble salts that may be taken up by growing plants. There are other forms of bacteria that live and form nodules on the roots of clovers, alfalfa, beans and peas and other leguminous plants. These bacteria gather nitrogen from the air and convert it into nitrates, thus placing an essential plant food where needed.

Phosphorus.—Phosphorus in combined form is found in small quantities in most all soils but rarely in sufficient quantities to fully meet the needs or growing plants. Nearly all soils will be highly benefited by the application of phosphates.

Calcium and magnesium.—These elements occur as carbonates in small quantities in most all soils and abundantly in some soils. Carbon dioxide and water form a soluble salt of these carbonates which can then be taken up by the roots of plants. These elements enter, for the most part, into the making of the seed of plants as is also the case of phosphorus.

Potassium.—This is also an essential element of plant food. Most of its compounds are readily soluble in water so that it easily leaches and is carried away by rain waters, making it necessary to continually apply potash to soils for best results. Ashes of land plants are rich in potash.

Sulphur.—This element occurs in soils in the form of sulfids usually of iron, or as sulfates of such materials as calcium, iron, and magnesium. The sulfates are readily soluble in water.

Iron.—This is an important plant food but it is so abundant in soils that there is no deficiency so far as the needs of plant growth are concerned.

A number of other elements are also of more or less importance as plant foods, but for the most part they are in sufficient quantity in soils to meet the demands of growing plants.

SOME GENERAL TYPES OF ARKANSAS SOILS

It has been explained that soils vary in their characteristics according to the rocks from which they are derived, the amount of organic matter they contain, and the manner in which they have originated. Varying proportions of sand, clay, organic and mineral constituents and manner of origin make an endless variety of soils if minutely classified. For present needs we shall discuss only some of the larger groups of soils.

Alluvial soils.—The alluvial soils of our larger river valleys and flood plains come from many different kinds of rock and organic matter that is found over the drainage area of the river. The particles entering into these soils are fine and thoroughly mixed and are built up to considerable thickness. These soils are the most fertile of all our soils and they require but little except proper tillage to make them produce heavily. The alluvial soils along our smaller water courses are very much like those just described except that the range of rock beds from which they come is more limited and the materials do not average quite so fine and the soils not so deep. While all the alluvial soils are fertile, they, in a general way, decrease in fertility as the drainage area from which they are derived becomes smaller.

Soils of swamp lands and poorly drained areas.—These soils have been formed on the outlying areas of river flood plains and represent the last sediments to settle from the flood waters, so the sediments are very fine and largely clay and organic matter. Vegetation growing over these low-lying areas continually adds to the soil partially decayed vegetable matter. These soils are sour or acid, but after proper drainage and heavy liming become very fertile soils.

Residual soils.—These form the greater part of our soils. As has been shown they vary according to the nature of the underlying rock from which they are derived. In the east, southeast, and west central parts of the state they are sandy or clayey soils. In northwest and southwest Arkansas they are sandy and clayey soils for the most part but considerable areas there have highly calcareous soils. The areas in which calcareous soils occur are shown on the accompanying map as areas that have limestone, chalk or marl beds.

SOIL IMPROVEMENT BY THE APPLICATION OF LIME, CHALK, MARL AND PHOSPHATES

Lime application to soil.—Several references have already been made about certain effects that lime produces on the soil, but we may now review and group together these effects for a clearer exposition. Lime floculates clay and cements rock particles into larger grains, thus making the soil more porous, which condition allows better areation, easier tillage and penetration for the roots of plants, easier absorption of rain waters, makes the soil less strong in capillary action thus decreasing loss of soil moisture through evaporation. Lime fosters nitrate production by making the soil neutral or alkaline, which condition is favorable for the life and activity of nitrate-producing bacteria, especially those forms that live on the roots of clover, alfalfa, beans, peas and other leguminous plants. Lime "sweetens" the soil. Most plants do not thrive well in acid soils and the acid condition may be readily corrected by applying lime. Moreover, bacteria destructive to nitrates thrive in acid soils, so the liming prevents the destruction of nitrates. Liming promotes availability of phosphorus and potash by helping to convert unsoluble salts of those materials into soluble forms. Liming the soil where fruits are grown makes the fruits sweeter.*

Liming of soils gives greater crop yields, as has been many times demonstrated at various agricultural stations. For example, at the Tennessee Agricultural Experiment Station* an application of two tons of ground limestone to the acre produced increases in the yield for eight years, as follows:

*Ground limestone and prosperity on the farm, by C. A. Mooers, p. 194.

Crop	No. of Crops	Increase per A.
Cowpea hay	2	0.92 tons
Wheat	2	6.10 bushels
Clover hay	2	2.29 tons
Cotton	1	46. lbs. (seed cotton)
Corn	1	6.10 bushels

It has also been shown by different experiments that the beneficial effects in crop production is cumulative. In other words, the second year after soil treatment greater increase of the crop will be noted than was obtained the first year because the soil for the second year will have a better supply of nitrates than it had the first year. It is a common saying that "A limestone country is a rich country," and the truth of this statement is readily verified by observation. In the liming of our soils we practically convert our lands into a limestone soil country.

Forms in which the lime may be applied.—Either limestone, dolomite, or chalk may be used in liming soils and so far as results are concerned

*Soils, by Hilgard, p. 380.

*Ground Limestone and Prosperity on the Farm, by C. A. Mooers, p. 194.

there is but little difference; however, it is important that the calcium content of the soil be kept equal to or a little more than the magnesium content. Most of our soils, so far as available analyses show, have slightly more magnesia than calcium, so it is better that our limestone or magnesian limestone should have a higher content of calcium than magnesium.

For application these materials may be ground or crushed raw rock (the carbonate forms), or we may use burnt (quick) lime. If the latter form, it may be applied as air slacked lime, as ground quick lime or prepared hydrated lime. If the haulage is a long one it is sometimes better to use the quick lime, which is in the form of an oxide and weighs less for a given amount of available lime. For example in approximate terms two parts of oxide of lime (quick lime) are equivalent to three of hydrate or four of carbonate of lime.

If the lime is applied as quick lime, either hydrated or oxide, it is soon converted to the carbonate form.

Lime is leached from the soil very slowly, so that a single application of one-half to one ton of burnt lime or twice that amount of ground limestone (carbonate of lime) is sufficient to last for five to ten years for the average soil. If the soil is strongly acid more than the above named amounts will be required. A light sandy soil only slightly acid would not require as much as the heavier soils, for such a soil probably one-half a ton of lime oxide (quick iime) per acre, applied every five years, would be all that the soil would require.

In applying the lime to the soil it should be distributed evenly. Thorough distribution in the soil to the depth of five or six inches is desirable, but distributed on the surface of freshly plowed ground usually proves satisfactory.

Practically all our soils would be benefited by the application of lime, but some of the limestone soils of northwest and southwest parts of the state would need but little, if any. The swamp soils of eastern and southeastern Arkansas stand in greater need of liming than any of the other soils.

Available supplies of limeing materials.—It is fortunate for the state that there are such great quantities of limestone, dolomite, and chalk in the state that are of excellent quality and easily accessible. The dolomite rock occurs in the northeast part of the area marked limestone bearing on the accompanying map. For use in the southern counties of the state the chalk deposits will be for the most part more accessible than the limestone of the northwestern part of the state.

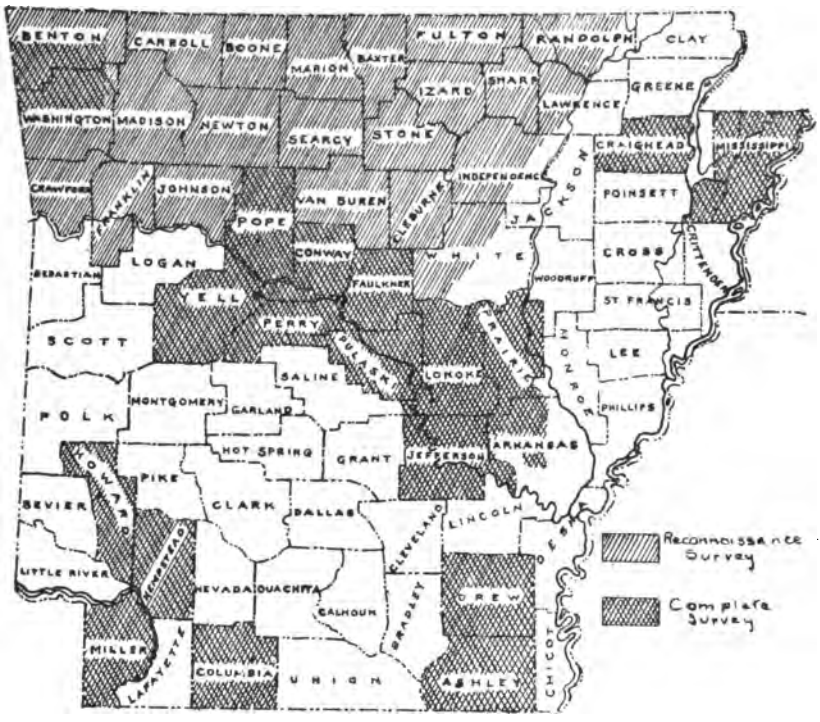
MARLS

Marls.—The marls of southwestern part of the state are adapted to use on soils in very much the same way as limestone, only the marls usually contain but forty to fifty per cent of lime carbonate and, so far as available analyses show, only about two-tenths of one per cent of phosphoric acid. These marls are easy to mine and handle, but because of low lime content in comparison to limestone and chalk, will not stand the long haulage that more concentrated lime bearing rocks will.

Phosphates.—Reference has already been made to the importance of phosphates in the soil for good crop production. From practical experience as well as theoretical calculations, it is found that nearly all soils are benefited by the applciation of phosphates. Where the soil is naturally calcareous, or where lime has been liberally applied to the soil, it does not require so much of the phosphates and where iron is abundant in the soil more phosphates are required. Phosphates may be applied to the soil as the ground raw phosphate rock or as prepared acid phosphate. The latter is more readily available as plant food.

So far as present investigations have been made the only source of commercial phosphate rock in the state is the phosphate beds in the Batesville region shown on the accompanying map.

The phosphates of this area run rather high in iron and the beds that have a fairly high phosphorus content are not very thick; it is believed, however, that these deposits will prove of much help in making the soils of the state of greater productive value.



Area of Surveyed Soils in Arkansas

SOIL SURVEYS BY THE FEDERAL GOVERNMENT

The state has made no soil surveys in Arkansas, although considerable work has been done in soil study and fertilizer experiments under the direction of the State Experiment Station at Fayetteville. The United States Bureau of Soils has completed detailed soil surveys in fifteen different areas in as many different counties, has made a general soil reconnaissance of the Ozark region (north from the Arkansas river and west from the main line of the Missouri Pacific railroad) and has surveys in progress in three other counties. The surveyed area is shown in the accompanying map. The list of soil survey bulletins, copies of which may be obtained on request from the U. S. Bureau of Soils, Washington, D. C., follows:

Ashley County, by E. S. Vanatta, B. D. Gilbert, E. B. Watson, and A. H. Meyer, 1914.
Columbia County, by Clarence Lonnsbury and E. B. Deeter. 1910.
Craighead County, by E. B. Deeter and L. Vincent Davis, 1917.
Conway County, by Jas. L. Burgess and Chas. W. Ely, 1908.
Howard ounty, by M. W. Beck, M. Y. Longacre, F. A. Hayes and W. T. Carter, Jr., 1919.
Fayetteville Area, by Henry Wilder and Chas. F. Shaw, 1907.
Hempstead County, by Arthur E. Taylor and W. B. Cook, 1917.
Jefferson County, by B. W. Tillman, G. G. Strickland and others, 1916.
Mississippi County, by E. C. Hall, T. M. Bushnell, L. V. Davis, Wm. T. Carter, Jr., and A. L. Patrick.
Ozark Region of Missouri and Arkansas, by Curtis F. Marbut, 1914.
Pope County, by Clarence Lonnsbury and E. B. Deeter, 1915.
Prairie County, by Wm. T. Carter, Jr., F. N. Meeker, Howard C. Smith and E. L. Worthen, 1907.
Stuttgart Area.
Yell County, by E. B. Deeter and Clarence Lonnsbury, 1917.
Faulkner County, by E. B. Deeter and H. I. Cohen.
Drew County, by B. W. Tillman.
Perry County, in progress.
Lonoke County, in progress.
Pulaski County, in progress.

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